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THE GREAT RED SPOT ON JUPITER.

BY RICHARD A. PROCTOR.

PROFESSOR YOUNG in his farewell address to the Philadelphia meeting of the American Association for the Advancement of Science, spoke of the great red spot which has for many years been the most remarkable feature of the planet Jupiter as a mystery "probably hiding within itself the master-key to the constitution of the great orb of whose inmost nature it was an outward and most characteristic expression." Without altogether accepting the view of the red spot thus metaphorically presented, I must most thoroughly express my agreement with the opinion underlying Professor Young's rhetoric. The great red spot on Jupiter is undoubtedly the most mysterious of all the phenomena which even the Prince of Planets has presented to the student of astronomy. A vast opening, about 150 millions of square miles in extent, lasting many years, undergoing changes of shape and of position most remarkable in character, this great red spot undoubtedly contradicts emphatically all the old-fashioned ideas respecting Jupiter: and it as certainly presents many perplexing questions for those to answer who have adopted the more modern ideas.

Yet it has always seemed to me that the more remarkable a phenomenon is the better is it worth studying, and the more likely is it to reward careful study by truthful information. A perplexing problem of this kind may be compared to a complicated lock, which will not open to any ordinary key; but when a key which will open it has been found then may we feel well assured that that key is the right one; whereas when a commonplace phenomenon has been accounted for, we can have no more certainty that our solution is right than we can feel respecting a key (one perhaps among a dozen) which will open a lock of commonplace construction. Without claiming that as yet the correct solution of the problem of the great red spot has been found, or even that it can be, let us proceed to examine the problem with a view to the determination of at least some of the points which the true solution must interpret.

It was in the year 1876 that the great red spot was first observed—by Professor Pritchett of Glasgow, Missouri. But I have before me a picture drawn by Professor Mayer, of the Stevens Institute, Hoboken, in 1871, wherein the place afterwards occupied by the spot is marked by an oval ring of about the same size and shape. Whether this was actually the first beginning of the disturbance, or merely a coincidence, cannot now be very readily determined: but it is at least worth noting, even though it should be no more than a coincidence.

When first observed the great spot was symmetrical and well defined in shape, and of a somewhat strong ruddy tint. It was about 150 millions of square miles in extent (as was also the space enclosed within the oval ring seen by Professor Mayer). The greater axis of the oval was nearly three times as long as the shorter, but part of the difference was due to foreshortening. From a study of several hundred pictures I am led to conclude that the greater axis of the spot was not more than $2\frac{1}{2}$ times longer than the shorter axis. Observations made by the late Professor H. Draper with the spectroscope seem to suggest that the light of the ruddy spot was in part inherent; but others question whether the evidence accepted by Professor Draper was altogether valid. The spot continued visible, with little change of form or colour for about six years, after which time, though it remained visible, it lost its symmetry of form and its characteristic ruddy tint. It was half-veiled for a time (at least in appearance) by the extension of a cloud belt lying north of it, as though this cloud belt lying at a higher level had spread farther and farther over the spot. At present the spot, or rather the traces of the spot, can still be seen; but it no longer presents any of the features, except enormous extension, which made it so remarkable a feature of the planet from 1876 to 1882.

It was noteworthy that compared with the equatorial markings on Jupiter the great spot seemed to lag, as if the equatorial cloud belt were whirled round in a shorter time than the side zone on which the spot was seen.

The first point to be noticed, in this remarkable phenomenon, appears to me to be that which the eye first recognises, the symmetrical shape which the spot presented. Of course the spot was less symmetrical when seen with high powers than when observed with a small telescope; but the symmetry of shape was none the less remarkable that it belonged to the spot as a whole rather than to the spot when minutely examined and largely magnified.

Of course symmetry of form implies, in such a case, uniformity in the action of the forces at work in determining form,—in this case, uniformity in the action by which the spot was produced. The path along which a projectile travels is uniform, apart from atmospheric resistance, because a uniform force is at work on the missile from the beginning to the end of its career. The action on the projectile is along lines always parallel and vertical; consequently the symmetry of the path is related to the vertical: a vertical line divides the path into two portions perfectly resembling each other. Again, the course of a planet round the sun, or of a ball swung round a centre, is symmetrical, because of the uniformity of the forces directed towards the centre. In one case the path is elliptical, in the other the path is circular, but in each case the central nature of the forces at work on the moving body tend to make the path symmetrical with reference not to a line but to a centre. Again, observe a whirlpool, a tornado, the shapes of the clouds seen around a volcanic crater during eruption, and even

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the rounded forms of summer clouds, and we see in each case how tendencies towards or from a centre result in giving uniformity of shape to the aggregation of matter resulting from such tendencies. The existence of a shape centrally symmetrical, whether circular or elliptical, implies in every case the existence of forces tending either from or towards a centre. I know of no exception to this rule in nature, though of course artificial productions may show symmetrical forms without giving evidence of central forces.

We may assume then that whatever were the forces at work in forming and maintaining the great red spot on Jupiter, they were related in some way to the centre of the oval region affected by them. They may have produced motion from that centre, or motion towards it, or there may have been movements of both sorts: but assuredly central forces were at work in some way or ways, where the great red spot was formed.

While the symmetry of the spot's shape forces on us this general conclusion, the greater length of the spot in one direction than in another possesses also a special significance.

(To be continued.)

THOUGHT AND LANGUAGE.

By Ada S. Ballin.

XIV.

I HAVE spoken at considerable length of the deaf and dumb, a class shut off from the use of articulate speech by physical inability, which may, to a certain extent, be overcome by long years of patient teaching on the oral system, but I have now to speak of a class of unfortunates who, although by no means idiotic, are, through brain disease, deprived of the use of verbal language. In this class I do not include those cases where the power of using language is lost, but that of understanding it is retained, or such cases as the following, mentioned by the late Sir Benjamin Brodie—the case of a gentleman, who, two years after an apoplectic stroke, suddenly lost the power of speaking and of understanding articulate speech, while still able to read and write. A letter read to him conveyed no ideas to his mind, but if he read it himself he understood it perfectly. He recovered from this attack, but had a similar one afterwards. Although these are of great interest from a pathological point of view, they do not imply loss of control over language as such.

In the understanding and production of language many brain centres are implicated,* but its intelligent use is dependent on a comparatively small cerebral area, namely, the posterior half of the third frontal convolution, as it is called Broca's Convolution, and especially that of the left hemisphere. This is supported by the fact that some degree of right-side paralysis generally co-exists with the affection of the faculty of speech by brain disease. Movements of the right side of the body are dependent on action of the left side of the brain, and the development of the left hemisphere corresponds to the superior activity of the right hand over that of the left. In the comparatively rare cases of left-handed persons the right side of the brain has attained the higher development, and in these cases when left-side paralysis co-exists with injury to the faculty of speech *post-mortem* examination reveals damage to Broca's Convolution on the right side. Injury to the brain-centres on which language depends may exist in any degree of severity, from mere functional affection to total destruction, and speech is correspondingly impaired or lost.

Case 1.—An interesting case has been recorded by Dr. Banks,* in which a gentleman, aged about seventy-five, suddenly lost all power of understanding what was spoken by others, and retained but a slight ability to understand written or printed matter. He could not himself use words intelligibly. *It was impossible to get him to understand anything*, and his meaning could only be guessed at by his gestures; and the very few words he retained were generally misapplied. Wishing to inform his medical attendant, Dr. Kidd, that his bottle of liniment was nearly empty, he said, "Bring the cord;" at another time he spoke of the pills he had been taking as "potatoes." One day, when giving his waistcoat to be put away, with his watch in the pocket, he said: "Take care of the break-fall." He was quite deaf. His powers of speaking and writing varied at different times; the letters sometimes containing properly-written words, but being almost unintelligible. He wrote his address several times on different sheets of paper, but some of the words were imperfect. "My dear sir" was written correctly, but the sheet was filled with meaningless writing, only the one word, "wife," being legible until the signature, which was in his usual hand. An indication that his intelligence was fairly retained is given by the fact that at the time when a remittance was due from his agent he was much excited every morning, asking often for something. At last it occurred to one of the family to show him his agent's letter. This pleased him; but he was not quite satisfied until the money was brought and counted in his presence. Some shillings were not shown him at first, but when he saw them he seemed to know all was right.

Case 2.—A much more severe case is related by Dr. Broadbent† of a painter, aged 42. His speech was a mere jabber, in which "Ma" and "Mum" were prominent; it was accompanied with excessive gesticulation, smiles, and facial expression. He seemed not to recognise the state of his speech, for he continued to jabber as if he thought he was understood; but he also made signs. "The gestures," said the doctor, "were very striking, when we had a key to their meaning. . . . It was stated that he said 'Yes' or 'No,' and 'Oh, my!' at times; but he did not use even these simple words before us." He could not write intelligibly, nor even copy his own signature. He did not understand what was said to him, and repeatedly put out his tongue when told to close his eyes; but imitated the desired act after Dr. Felce.

Case 3.—Trousseau mentions the case of a lady who was very rational in her actions, but used words quite irrelevantly without perceiving it. She rose courteously to receive a visitor, and, pointing to a chair, said, "Cochon, animal, fichu bête!" which her son-in-law explained by saying, "Madame vous invite à vous asseoir."

Case 4. A striking case of complete loss of control over language, with retention of the power of understanding it and of intelligence as shown by actions and gestures, is that of M. X——, recorded by Trousseau, who

* The physiology of the subject is fully treated in Dr. Bastian's work, "The Brain as an Organ of Mind."

* *Dublin Quarterly Journal of Medical Science*, February, 1865, p. 78. I number the cases quoted here to facilitate the references which will be made to them in the succeeding article.

† *Medico-Chirurgical Transactions*, 1872, p. 170.

saw the patient some months after an apoplectic stroke. He says: "His face was intelligent, cheerful, and full of benevolence. He seemed by his gestures, and especially by the expression of his face, pleased to see me." He could only utter, in a faltering voice, unintelligible words in which "*Yes*" was frequently repeated. To all questions he answered "*Yes*," even when he shook his head in denial;* but he made an impatient gesture, and looked annoyed when it was wrongly applied, while appearing pleased when it was properly used. At dinner he ate with his left hand, not having recovered the use of the right, but ate with propriety, and looked after his guests, taking part in some of the conversation, as for instance, when the lamb of the country was praised he nodded assent, while he shook his head disapprovingly when one of them said the kid was a better flavour than the lamb. He signed to the servants to hand the wine, and when it was of an esteemed vintage indicated that it should be drunk in preference to the others. He played "All Fours" with as much skill as ever, sometimes sacrificing a card to improve his game; and, although his son managed his affairs, insisted on being consulted about his leases, contracts, &c., indicating by gestures when certain parts of the deeds displeased him, and not appearing satisfied until alterations were made which, as a rule, were useful and reasonable. His sight was good, but he could neither read nor write, nor even put letters of the alphabet together; he listened, however, with pleasure to reading aloud. He told his age, fifty-seven, in a complicated way on his fingers. Once he dropped his handkerchief, and when a lady picked it up, uttered the word "*thanks!*" loudly and distinctly; but, though entreated to say the word again, he could never succeed, and could not even repeat the simplest sound which had been uttered before him. I look upon the pronunciation of the word *thanks!* in that case as a mere emotional gesture; a cultivated gentleman like the patient, if in possession of speech, would, in the above circumstances, utter that word spontaneously and without thought; from much use it becomes wholly automatic, and is, I believe, produced by the stimulus of a slight act of courtesy, without that stimulus necessarily reaching the higher centres of the brain. In the case of M. X., the stimulus was a very strong one on the occasion mentioned, owing to the fact that it was a lady who restored his handkerchief, and he would naturally have been unwilling that she should have troubled to stoop for it. Dr. Bazire, the translator and editor of Trousseau's "Clinical Lectures," from which the above case is taken, adds to it one which occurred in his own practice—a case of much greater severity, as it was accompanied by considerable mental impairment; it is particularly noticeable that the gestures performed by this patient lacked the clearness which characterised those of M. X.; their defects having been caused by a more serious injury to the brain. She, however, at once understood the gestures of others, and her condition regarding gestures may be compared to that of M. X. with regard to words which he could understand, although unable to use them.

Case 5. Three months before Dr. Bazire saw her, M. W. was attacked with paralysis of the right side; she dropped senseless, and on recovering her senses could utter nothing but "Sapon, Sapon," which from that time she continually repeated. "*She could not be made to understand at once by words alone what was required of her; and could not always answer correctly by gestures the questions which she was asked. Her pantomime was not so clear as that of a deaf and dumb individual, and she seemed not to be able to understand the meaning of words. They had to be spoken very slowly and repeated several times before she could catch their meaning, and she most frequently failed completely in this. Gestures she understood at once. Thus when I asked her to show me her tongue, she did not always do so immediately; but on putting out my own tongue, and then making signs for her to do the same, she instantly complied. . . . She held her pen properly (with the left hand), but only made a meaningless scrawl. Although she kept constantly repeating 'Sapon, sapon,' I could never make her say 'sap' or 'pon' by itself, or repeat any syllable or word after me.* She knew her own name, and when I mentioned it, she laughed and pointed to herself. According to her sister's statement, she remembered localities and knew faces well." Nine months afterwards she was somewhat improved, still saying "*Sapon, sapon*"; but could distinctly say *yes* and *no*, although not always using them correctly, and could count *one, two, three, four.* Her sister said that under great excitement she sometimes exclaimed, "Oh, dear me!" a statement which agrees with the hypothesis that emotional expressions are retained as being on a lower level and more anciently ingrained in the race, when words expressive of thought are wholly lost. She could not yet write, though trying hard, nor even recognise the letters of the alphabet. She had still great difficulty in understanding what was said in words, though not at all deaf, but immediately understood gestures. Her own pantomime was still lacking in clearness. She was fond of looking at pictures. I have no clue to the origin of the word "Sapon," the only articulation used by this patient; but generally those words which, owing to great familiarity have become, as it were, ingrained in the mind, are those which are retained. Thus *yes* and *no* are the commonest, although, as above shown, they are not always used correctly. Next to this is the name of the patient and his address.

Case 6.—Thus a patient of Dr. Bastian's, partially paralysed on the right side after severe epileptiform attacks, sixteen days after the seizure could say *Yes* and *No* indistinctly and not appropriately. Nineteen days after that she had added the word "Nurse" to her limited vocabulary—a word which must have been constantly presented to her in the ward of the hospital where she was lying. *She seemed to recognise familiar objects, and know when the right name was given to them,* and to recollect her own name. She did not give signs of recognition when the name of the street she lived in was mentioned, but nodded at once when she heard the remaining part of her address, "Fitzroy-square."

Case 7.—Dr. Samuel West, at a meeting of the Medical Society,* recounted a case of aphasia, with some loss of power and sensation in the right side. The patient, in accordance with the observation made above, retained some words in common use, such as "Good morning," "Yes," "Order," "Corner," "One or two with it"—a phrase he had occasion to use frequently in his occupation as carrier. When attempting to say more his utterance became wholly unintelligible, but occasionally he said "I can't," or "I couldn't." Although understanding the use of visible objects, he could not name them. He made futile attempts to write, and could not read, although he held the paper the right way up. He understood very little that was said to him, but

* A similar case is mentioned by Dr. Bastian, whose patient was utterly unable to speak, although his intelligence was, to all appearance, unimpaired. His only word was "*No*," which he used in answer to all questions, even when he nodded his head in assent.

* January 12, 1885.

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would perform certain acts when told to do so, and evidently understood simple questions. He sometimes repeated words spoken before him, but only in automatic mimicry.

COLOSSAL STATUES.*

BARTHOLDI'S STATUE OF LIBERTY.

UP to the present time no statue had ever been executed of the extraordinary proportions of the Statue of Liberty. In order to form an idea of this work, which was without precedent, it was necessary to give the greatest attention to the means of execution; it was necessary to foresee the elements of solidity and the exigencies of the transportation to America; finally it was necessary to seek to avoid heavy expenses into which one is rapidly drawn in a work of this kind, according to the methods employed. The examination of the various difficulties led us to adopt the system of hammered copper, which from an artistic point of view, offers elements of excellence, when it is well treated, which allows of a large subdivision in the pieces, and renders the transportation easy.

We will examine the various phases of the work. The total height of the first model was 1·25 mètres. This was the study-model, which was long sought and often recast. (It is the model which has been reproduced in terra-cotta, the number of the reproductions being limited to 200. Each model was numbered and registered, and a large number of them were sold in aid of the subscription under the name of the "Model of the Committee.")

After this first study, I made the statue, which measures from the head to the feet 2·8 mètres, and in its entirety 2·85 mètres. This statue, executed with rigid precision, was reproduced four times as large by the ordinary processes. The model which was the result of this work measured about 11 mètres in total height. Placed in a large space, it could be taken in by the eye in its entirety, and the corrections to be made could still be noted. This statue was divided into a large number of sections, destined to be reproduced separately at four times their size. After this last enlargement, changes were no longer possible. Now the sculptor could only aim at very great precision and at great care in the modelling of the surfaces, which were becoming enormous. It was necessary to study them in their simplicity and their nakedness, so that the form should be flowing and correct, without prominent details which would detract from the general appearance. In an immense workshop, specially constructed for the work, were to be seen four plane surfaces on which the work was carried on. They were encompassed with frames, laid out in numbered divisions. Another similar frame, corresponding exactly to the one below, was fastened beneath the ceiling of the workshop. Lead wires and rulers hung all round the frames. On these frames, thus geometrically laid out, the sculptors executed in wood and in plaster enormous fragments of the statue. The sections of the model that they were to reproduce were arranged near by under corresponding conditions, between frames of one-fourth the size. The sculptors executed the enlargement by measurements taken with the compass on the lead wires and the rulers. They first laid out the general form with wooden beams covered with lath-work. The wood was then covered with a coating of plaster. They verified the large measurements already established, and then executed the reproduction point by point, and finished the modelling of the surfaces. Each nail head and point marked requires six measurements, three on the model and three for the enlargement, without counting the verifying measurements. There were in each course about 300 large points and more than 1,200 secondary points, which represented for each course the work of establishing about 9,000 measurements. When a course was finished the carpenters took its forms by means of boards cut in profile, according to the form of the plaster. They were applied on the spot, placed one opposite to another and crossed, thus forming pigeon-holes, larger or smaller. Thus they took a sort of impression. In these wooden moulds or *gabarits*, the hammerers pressed the sheets of copper by pressure, with levers, and by hammering with mallets. The pieces of copper were finished by beating them with little hammers and with rammers. The profile of the forms was again taken in detail with

Wooden frame-work and process of modelling the left hand of the statue in plaster.

sheets of lead, pressed upon the model, again working the copper according to the profiles. The pieces of copper were furnished from point to point with iron braces, intended to give them rigidity. These braces were forged in the form of the copper when the contour of the latter was completely modelled. Thus furnished the pieces were carried to the mounting in the court, to be brought together and fastened on the powerful trusswork of iron beams which serves as support for the whole envelope of the statue. The core of this trusswork is formed by a sort of pylon which has four points of attachment. Each of these points is sustained by three bolted braces, 15 centimètres in diameter, which are made fast at a depth of 8 mètres in the masonry of the foundation to a frame of iron beams. The whole trusswork was designed and executed by the eminent constructing engineer, M. Eiffel.

This trusswork serves as a support for the copper form of the statue. The copper plates, kept in shape by iron bands, are supported by iron braces, which are cramped on to the central core. They do not bear in the least

* From the *New York Tribune*.

upon the lower plates, and their weight is always independent of all that is above and below.

Exhaustive mathematical calculations were made upon the resisting power of the iron pieces, upon the centre of gravity and upon the action of high winds. The calculations were made by taking as a base the most powerful hurricanes which have been recorded either in America or in Europe. In regard to the preservation of the work, since all the elements of its construction are everywhere visible on the inside in all their details, it will be easily kept in good condition.

To end this account I ought to add to it a few bits of statistical information, although they have been published on various occasions. The whole work was done in the celebrated house of Gaget, Gauthier & Co., of Paris. The statue is constructed of copper sheets, two and a half millimètres in thickness. It measures 46·08 mètres from the base to the top of the torch, 35·50 mètres from below the plinth to the crown, 34 mètres from the heel to the top of the head.

Statue of Liberty mounted on pedestal, with New York and Brooklyn Bridge in the background.

The forefinger is 2·45 mètres in length, and 1·44 mètres in circumference at the second joint. The nail measures ·35 mètres by ·26 mètres. The head is 4·40 mètres in height. The eye is ·65 mètres in width. The nose is 1·12 mètres in length. About forty persons were accommodated in the head at the Universal Exposition of 1878. It is possible to ascend into the torch above the hand. It will easily hold twelve persons. The total weight is about 200,000 kilos, of which 80,000 are copper and 120,000 iron. It represents an outlay of more than a million francs, including gifts, gratuitous work, and the losses of all those who gave their devoted assistance to the work.

The colossal statues which have been executed up to the present time are far from the proportions of the Statue of Liberty. I have given above some indications on this point. Yet we must not expect its appearance to be colossal when it is in its place. In the immense picture which will surround it it will appear simply in harmony with the whole, and have the normal aspect of a statue in a public place. It should be thus, because its part is not to appear extraordinary in itself, but to connect itself intimately with an extraordinary whole.

The statue was born for this place, which inspired its conception. May God be pleased to bless my efforts and my work, and to crown it with the success, the duration, and the moral influence which it ought to have. I shall be happy to have been able to consecrate the best years of my life to being the interpreter of the noble hearts whose dream has been the realisation of the monument to the French-American Union.

ILLUSIONS OF THE SENSES.

By Richard A. Proctor.

(*Continued from page* 90.)

I HAD a singular example recently of the effect of position in forcing an illusory idea on the mind, even when the truth was well and even familiarly known. I was in the streets of Charleston (South Carolina) engaged in conversation, but my eyes directed towards the upper ridge of a projecting balcony. While I talked, I saw what looked like a bird's head rising just beyond the ridge, and in a moment or two there was the creature, a tiny but very oddly shaped bird apparently fluttering above the balcony. It looked no larger than a humming-bird. Now I knew at once that I was not looking at a bird, because I could see that the object had a pendent waving tail such as no bird ever had. I knew as well that it was not a small bird close by, but a Chinese kite at a considerable distance, as I knew that it was day; yet because my mind had started with the wrong idea that the object was just above the balcony, I could not for several seconds shake off the absurd impression that there was a miniature bird-kite fluttering above a straight stone ridge where assuredly was no string attached to it. I take it that the deception by which, against my own knowledge, I was for awhile made to imagine the kite much smaller than it really was, because it seemed much nearer than such an object is usually seen, was precisely akin to the illusion by which, against our own knowledge we are led to imagine the moon much enlarged near the horizon because it there seems much farther away than as seen high up towards the zenith.

The illusion as to the shape of the heavens around us and the sky above us (not the same thing be it noticed) is one which deceives us all the time,—at least, I have never met with anyone who has been able to correct either form of illusion. We conceive the heavenly bodies overhead to be nearer to us than those near the horizon, the heavenly concave being presented as somewhat flattened overhead: and on the other hand a cloud-covered sky appears arched overhead instead of having a flat horizontal surface. Do what we will we cannot force the mind to feel either that the stars overhead are no nearer than those by the horizon, or that the clouds near the horizon are as much farther away than those overhead, as they really are. The clouds low down seem somewhat farther away than those above our heads,—perhaps four or five times farther: but in reality they are usually twenty or thirty times farther from us. But the mind refuses to present to us the much greater distance of those low-lying clouds.

It may be said indeed that the mind is unable to conceive a spherical surface, either convex or concave, beyond

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a certain size which differs probably in the case of each person, differs certainly as life advances, and is far short of the dimensions of any one of the celestial globes, except possibly the moons of Mars. It may be that if living in Fear or Terror (as the attendants on Mars have been called) we might recognise the rotundity of the surface of our home, seeing that probably neither of these moons has a diameter of more than twenty miles. But it is certain that no one can appreciate the rotundity of our earth, in such sort that not merely the circumstance that the globe is rotund is recognised, but the dimensions of the globe of which the region we see at any moment is a part. The best proof of this is found in the fact that the earth's surface appears concave so soon as we see any very large extent of it. As seen from a balloon, for instance, the earth seems like a gigantic basin, the mind not being able to take in the real truth that the earth is too large for the horizon to dip recognisably even when the eye is two or three miles above the earth's surface. If one could pass away from the earth to distances so great that she would be visible as a globe, we should still be unable to form any idea of her size,—just as now the sun, moon, planets, and stars tell the eye nothing of their real dimensions.

A curious question here suggests itself:—Supposing one could pass away from the earth's surface steadily till she appeared like a globe, what would be the changes her aspect would undergo? She would certainly appear concave until a great height had been attained; and as certainly she would eventually appear a globe as the sun and moon do: but in what way, I wonder, would the apparently concave surface pass to a manifestly convex surface? Would this happen gradually, or would the conviction suddenly force itself on the mind that the surface which had appeared concave was really convex? There is a familiar illusion which illustrates such a change as this, and seems to suggest that the change of appearance would be sudden. If you look through a lens, inverting the object seen, at a convex surface, it appears to be concave (a coin under the same conditions appears to have all the parts which are really in relief depressed) because the mind recognises the evidence given by the shadows without being conscious that this evidence has been inverted by the action of the lens. Now if, while the convex surface thus appears concave you introduce into the field of view some object which shows which way the shadows really fall—as an upright pin, or the like—you find the seeming concavity at once changed to convexity, the mind being unable to note how the change takes place, so rapid is it. Possibly this would be the way in which the seeming concavity of the earth would change to convexity, as we passed away to the distances at which the earth would appear like a celestial orb.

Illusions affecting our ideas about the apparent brightness of objects are even more deceptive than those affecting form. The French astronomer Chacornac wrote an article once in explanation of the superior brightness of the discs of Jupiter and Saturn near the edge. The explanation was ingenious, and would have perhaps thrown light on the nature and condition of the giant planets, if it had only chanced that the superior brightness which he explained had a real existence. As a matter of fact, however, so far are the parts of Jupiter and Saturn near the edge of their discs from being brighter than the parts near the middle, that the precise reverse is the case, and in quite a marked degree. I was first led to observe this by theoretical considerations, which seemed to suggest that the light from the parts of Jupiter near the edge ought to be very much less than the light from the middle of the planet's disc. It so chanced that just as I had satisfactorily reasoned this out, I came across Chacornac's article explaining why the edge is so much and so obviously brighter than the middle. This led me to inquire whether the case really were as he supposed or not. Now, to those who have paid attention to the phenomena of Jupiter's satellites, many circumstances are known which show that the edge of Jupiter's disc must be darker than the middle. For example, a satellite looks light when near the edge, dark when on the middle of the disc; or else, (which proves the same thing) a satellite is scarcely visible near the edge, being so nearly of the same lustre as the planet, but as it passes on to the brighter central parts of the disc it becomes a dark spot, sometimes even looking as dark as its own shadow close alongside. All this in reality proves that the edge is darker than the middle of the disc; yet it looks decidedly brighter. I suggested, therefore, to a friend who was making experiments on the luminosity of various celestial bodies, that he should test this matter by determining whether the parts of Jupiter's disc near the edge or the parts near the middle remained longest visible when the light of the planet was gradually extinguished by means of a neutral-tinted darkening glass (graduated from almost complete transparency at one hand to almost complete opacity at the other). The result was decisive, and exactly contrary to the evidence of the eyes. The parts which to the eye seemed so obviously the brightest were the first to yield to the absorption of the light, the parts which looked least bright remained visible longest. Of course, the illusion is easily explained. By contrast with the black background of the sky the parts near the edge of Jupiter and Saturn look brighter than they really are.

A noteworthy illusion was passingly indicated in what I have just described. I have said that a satellite sometimes looks as dark as its shadow close alongside. Now the shadows of the satellites look black; but the satellite itself cannot be black. We see then that the appearance of blackness does not necessarily imply real blackness. So the spots on the sun look black near the middle of the umbra; yet they cannot be really black there; and indeed when examined so that the effect of contrast is avoided they are found to emit a considerable amount of light. Another case of illusion may be noticed in total eclipses of the sun. Here the body of the moon looks black; yet in reality it is lit up at least twelve times as brightly as a landscape under full moonlight, for the earth is at the time of solar eclipse shining full upon the half of the moon turned earthwards, and her disc is 13½ times as large as the moon's appears to us. To my mind, one of the best proofs of the brightness of the solar corona, is found in the seeming blackness of the moon's disc during total solar eclipse.

But the seeming whiteness of the moon's disc when she is full is quite as much an illusion as its seeming blackness when she is between the sun and us. For the moon is not really white. She is much more nearly black. Regarding 100 as representing perfect whiteness, the average tint of the moon's surface would be represented by only 17. Probably the darker portions, which, when she is full look only slightly less white than the rest, are as dark as our porphyries and syenites.

Another remarkable illusion affecting brightness is that which has deceived several students of the moon in the case of the floor of the lunar crater, Plato. This broad expanse seems to grow darker as the sun rises higher above its level; but this is a pure illusion, due to the gradual diminution of the black shadows of the sur-

rounding mountains. By contrast with these shadows the floor looks lighter than it really is; as they diminish it seems to grow darker; when they disappear altogether it looks darkest; and as they gradually grow larger in the afternoon and evening of the long lunar day there, the floor seems to get light again. As a matter of fact the floor gets brighter as the sun rises higher above its level, and darkens again as the sun gradually nears the horizon of Plato.

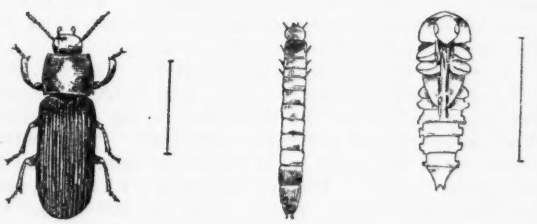
The illusions affecting motion are too remarkable and too numerous to be dealt with properly in the small space remaining to me here. I may perhaps consider them hereafter in a separate short essay.

OUR HOUSEHOLD INSECTS.

By E. A. Butler.

COLEOPTERA (*continued*).

WE conclude our notice of the family *Tenebrionidæ* with the creatures called "mealworms," which are the larvæ of two species of beetles, *Tenebrio molitor* and *T. obscurus*. Both larvæ and perfect insects are found in granaries, flour-mills, and bakehouses, where they sometimes do much damage to meal, bran, and flour. The larvæ are much more familiar objects than the imagos, though probably the reverse is the case with the rest of the family. They are used as food for certain singing-birds and other insectivorous creatures, and hence are bred in large numbers by bird-fanciers. This may readily be done by keeping them in bran, when they will propagate themselves freely. The word *Tenebrio* is Latin for a night-walker, or lover of darkness, and so far as the mere meaning is concerned, the name would be just as applicable to the rest of the family as to the present insects, the whole set being devotees of obscurity. *Molitor* is Latin for a grinder of corn, and *obscurus* finds its explanation in the dull appearance of the second species.



A B C

Fig. 1.—A, Tenebrio molitor; B, larva of ditto (natural size); C, pupa of ditto.

T. molitor (Fig. 1, A) is a narrow, parallel-sided beetle, a little over half-an-inch in length. Above it is almost black, the faintest possible tinge of a dark brown-red preventing it from being quite so; or perhaps it might be more correctly described as deep brown-red, so deep as to appear almost black; beneath and in the legs the lighter colour is much more apparent. It is slightly shiny, but only just sufficiently so to be redeemed from the utter dulness and dinginess which characterise its relative *T. obscurus*. Down the elytra run the inevitable parallel furrows, sixteen in number, not deep, but distinct enough to form a little "set-off" to the otherwise uninteresting appearance. The front of the head forms a ridge, which, as in some other species previously referred to, encroaches considerably on the eyes. The legs are rather short, and the antennæ are inelegant, thick, and stumpy. Unlike *Blaps*, it is furnished with wings, and therefore, of course, the elytra are not soldered together.

T. obscurus is a trifle larger than *T. molitor*, perfectly dull black above, without a trace of the red-brown tint, which, however, appears again on the under side; in other respects it is almost the exact counterpart of its slightly less inelegant congener.

Such are the parents of our mealworms; the "worms" themselves are as different as can well be imagined — long, narrow, cylindrical, caterpillar-like creatures (Fig. 1 B), consisting of a head and twelve similar and perfectly distinct segments. The colour is pale yellow, shading off into yellowish-brown towards the head and tail. Each segment at its hinder edge carries a rather broad band, and at its front edge an exceedingly narrow one, of the darker colour, so that the body is adorned with a series of double rings encircling it at intervals along its length. The last segment is rounded behind, and terminates on its upper surface in either one or two small black curved hooks. The head is furnished with a pair of not very large, but nevertheless strong, dark brown jaws, which, in repose, close in between the upper and lower lips, so that only their outer edges are seen. There are also a pair of tiny antennæ.

Under the three segments immediately succeeding the head are three pairs of short legs, each terminating in a sharp curved claw. By means of these the "worm" is able to progress at a tolerably rapid rate, provided there are sufficient irregularities in the surface to afford foothold to its tiny claws; but if transferred to a polished surface it presents a ludicrous spectacle; the front part of the body makes mighty efforts, struggling vigorously with its legs, and twisting itself from side to side, in vain endeavours to stir the inert mass of legless body which acts like a drag behind. The two legs in each pair are moved forward simultaneously, and the order of movement, which is not always quite uniform, and is extremely difficult to follow, appears generally to be first the front pair, then the third, and lastly the second. As the insect walks along, that part of the body immediately over the legs is, of course, somewhat raised, but the head is kept near the ground, so that it may feel its way with vibrating antennæ and palpi. When walking slowly, or endeavouring to extricate itself from a difficult position, it also makes use of a pair of fleshy tubercles underneath the front part of the terminal segment, thereby either helping the hinder part of the body forward, or acquiring leverage for the proper action of the legs. But when trotting briskly along there seems to be no necessity to call these tubercles into play, and the hinder part of the body therefore simply trails helplessly over the ground.

When fully grown the larva is nearly double as long as the beetle it produces, but what the latter loses in length it gains in breadth, as it is fully twice as broad as its ancestral worm. Having spent some months in devouring farinaceous substances, and changed its skin several times during that period, the "worm" enters its penultimate stage by another moult, but without forming any cocoon. It is now shorter and broader (Fig. 1. C), no longer a roving pirate, but a restful, helpless mummy, giving prophetic indications of its future destiny in its altered form—a beetle to all intents and purposes, but a caged and helpless one. After a few weeks the needful changes in its internal economy have been accomplished; it throws off its last skin, and appears a fully-developed winged beetle, at first soft and red, but destined soon to

acquire its natural firmness and pitchy colour. Previous to every moult, the mealworm acquires a bloated appearance, and becomes inactive for a time, lying on its side in a curved position, and resenting all interference with petulant twitchings of its form.

These mealworms will attack bread, cakes, &c., as well as uncooked cereals, and they have also been accused of devouring corks.

When we remember how many different species of "corn-loving" beetles occur in our corn-stores, and how excessively abundant some of them are, we are forced to the conclusion that many must often be ground up with the flour, and that we, therefore, sometimes get our bread adulterated with pulverised beetles, and unconsciously become "insectarians" for the nonce. But "what the eye does not see, the heart does not grieve over," and possibly we may not really be any the worse for this slight admixture of animal matter with our farinaceous diet, though there are not wanting those who have thought otherwise. Many of these "corn-lovers" are Heteromera, as we have seen, and to this section belongs also the blister-beetle renowned in medicine, and no very distant connection of our *Tenebrios*. Moreover, a Brazilian species of *Tenebrio* is known to eject from its body a caustic secretion, and some other allied insects cover themselves with a similar substance. Now if our mealworms, &c., have properties at all analogous to those of Spanish Fly, this internal application of cantharides, even in homœopathic doses, might not, perhaps, be altogether desirable. Some, too, have supposed the celebrated corn-weevils to be prejudicial to health when in a comminuted state.

Flour is not the only article of food that is liable to adulteration in this way. Curtis, in his "Farm Insects," has the following uncomfortable and suggestive passage: "I have known bushels of cocoa-nuts (*i.e.*, of course *cacao*) which were every one worm-eaten and full of maggots, with their webs, excrement, cast-off skins, pupæ, and cocoons, all ground down to make chocolate, flavoured, I suppose, with vanilla."

(*To be continued.*)

THE YOUNG ELECTRICIAN.

By W. Slingo.

(*Continued from p. 48.*)

Ex. XCV.—The form of rubber referred to in the preceding example is that pictured in Fig. 51,

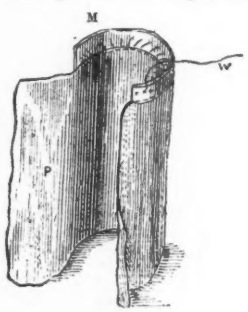


Fig. 51.

which consists of a pad, P, composed of a few layers of silk, large enough to surround the glass tube upon which the rubber is to be used. Along one edge of the pad a strip of thin brass or other metal, M, is stitched, and in it are pierced a number of small holes, the point of a pin being inserted and soldered into each hole. The points should all turn inwards, so as to pass close to the surface of the glass tube as the rubber moves along it. A piece of wire, W, is attached at one end to M; the other end being placed in the sand (Fig. 50), or wherever else the charge may be required.

Ex. XCVI.—Another kindred experiment is to suspend a pith ball from the support illustrated in Fig. 36 or Fig. 47, by means of a piece of silk thread or fibre. The approach of an electrified glass-tube results in the attraction of the pith-ball, which, coming into contact with the glass, becomes similarly electrified, and is consequently repelled. Although repelled by the glass, it will be energetically attracted by an electrified stick of sealing-wax. After contact with the wax, the electrification of the ball will be reversed, repulsion will set in, and the glass will next attract the pith-ball.

INDUCTION.

Pr. 4.—By induction is meant the electrification of a body by the influence of another body already electrified, near, but not in contact with it.

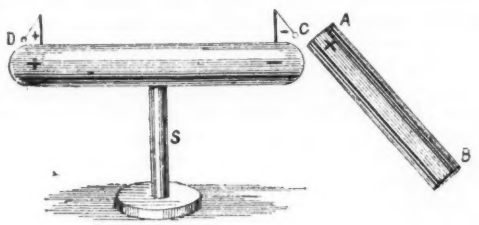


Fig. 52.

Ex. XCVII.—In Fig. 52 A B is a glass tube, of which the end A has been electrified and placed near the conducting body C D, which may be the orthodox brass cylinder with rounded ends, although it may be constructed in a much less elaborate fashion. Take half a sheet of foolscap paper, and make a rigid tube with it. To do this, procure a large ruler, or other round rod, an inch or more (two inches is a good size) in diameter, and roll the paper round the rod once; pull tight, and cover the upper surface of the remainder of the paper with flour paste, glue, or preferably with gum. Then wind the whole of the paper on to the rod or ruler, pulling it as tight as possible. Bind up the paper with string, and lay aside till the gum is dry, when the string may be unwound, and a first-class rigid tube will result. Provide the tube with rounded ends. A wooden ball (such as is procurable at a toy-shop) cut in half will answer this purpose very well, so also will a couple of tolerably round-egg-shells.

Or a solid wooden cylinder may be procured, the main features being that the sides shall be parallel, free from edges, ridges, or points, and the ends rounded.

The cylinder being produced, it requires a conducting surface, which may be imparted by coating it with tin-foil. This is easily done, tin being a very soft and ductile metal, and tolerably porous. Before being applied, the foil should be well smoothed, which may be done by rubbing it with any round body, such as a chisel-handle. This being done, and pieces of the requisite size and shape being cut off, the cylinder may be coated by a good application of flour paste, a little gentle pressure being all that is necessary to ensure the adhesion of the foil to the wood or paper (whichever may be employed). The

support, S, is made by fitting a half-inch glass tubing, well dried, into a wooden base, the upper end being closed with a cork or wooden plug, well dried, and fitted with marine glue, sealing-wax, pitch, &c. A headless pin or a needle driven into the plug furnishes a means for supporting the paper or wooden cylinder, C D. Near each end of the cylinder is a small support (a miniature of that depicted in Fig. 47), made from a piece of brass wire, and carrying a small pith ball, suspended by a piece of cotton thread. To ensure insulation it is advisable to close the bottom of the glass support by a plug fitted with sealing-wax, &c. The outer surface of the tube should also be painted or coated with a thin, even layer of shellac varnish (Ex. I.).

On the approach of the positively electrified rood A B, C D becomes electrified by induction, the near end C becoming negative (or opposite to the charge on A) and the remote end D becoming positive (similar to A). The pith balls take up the positions shown because they are charged similarly to the respectively adjacent ends of the cylinder and wire supports. Repulsion ensues from this. The ball at C also shares the attraction of A. On removing A B, C D relapses into its normal unelectrified state, and the balls again fall into the vertical position. This demonstrates that A B imparted none of its charge to C D.

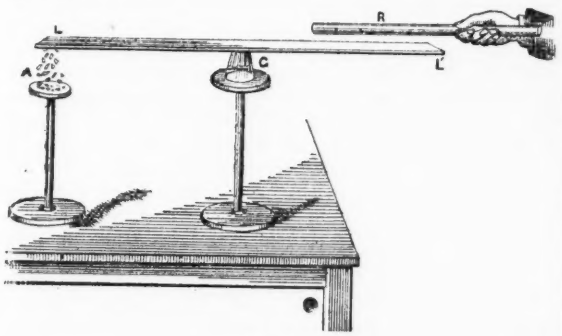


Fig. 53.

Ex. XCVIII.—We can show induction in another way. Hold an electrified rod, R (Fig. 53) over the end L′ of a wooden lath LL′ (Ex. LXXIII.), supported on an inverted tumbler, G, resting on any convenient support. The tumbler should be previously thoroughly warmed and dried for insulatory purposes. A is another support, uninsulated, and carrying a small quantity of bran, paper-clippings, gold-leaf fragments, &c. These substances are placed under the remote end L of the lath, and, on the approach of R, they are attracted by the lath. If R is positively charged, so also is L; the small pieces of paper, &c., become first charged by induction exerted by this charge at L; then they are attracted to L in consequence of their present negatively-charged surfaces; they come in contact with L, and consequently, becoming also positively electrified; they are therefore repelled; they in their repulsion induce an additional negative charge on A, come in contact with A, and become neutralised, when they are ready to be again inductively electrified and attracted by L. In this way, the paper particles are kept moving up and down between A and L until that end of the lath is discharged, *i.e.*, contains no more positive electricity. When this occurs, L ceases to attract the paper. If then R is withdrawn, the negative charge concentrated at L′ diffuses itself over the lath, and attraction, although feebler than before, is again exerted by L upon the paper.

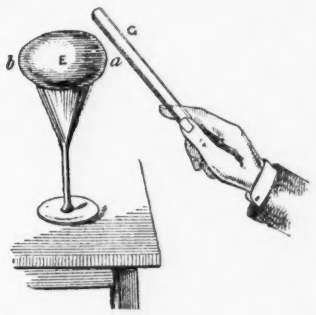


Fig. 54.

Ex. XCIX.—In Fig. 54 is shown another experiment of a somewhat similar character. E is an egg (an apple, a pared carrot, parsnip, turnip, potato, &c., will answer equally well); this is placed on a dry, warm wine-glass or other insulating support. The electrified rod, G, is brought near the end *a* of the egg. Induction ensues, and the two ends of the egg become oppositely electrified. If the finger be placed at the end *b*, it will practically remove that end of the egg to an infinite distance, when only one kind of electricity will remain, namely, that located at *a*. If, now, the finger is removed, and then G, E will be found to be electrified and capable of attracting light bodies, such as the suspended pith ball, &c. Of course, neither the finger nor any other conductor should be allowed to touch the egg, or it will be discharged.

HYSTERIA AS RELIGION.

AN Indiana journal has a long account of the strange doings of a so-called female evangelist who is going through the country holding revival meetings in which alleged "trances" figure conspicuously. It is complained by sober-minded and observing professors of religion that the effects of these revivals are evanescent, and that in fact the excitement passes as rapidly as it comes. The ministry have been accused of jealousy of these meetings and the leaders of them, but the general disapproval entertained toward such methods by thinking pastors rests upon far higher grounds.

Medical science does not hesitate to assign the methods here used for religious purposes to the category of diseases. The kind of trances into which the Indiana evangelist falls is not mysterious to the student of medicine. He recognises it as one of the manifestations of the many-sided disease called hysteria. And in the epidemic character of the emotional outbursts at such revival meetings the influence of similar abnormal conditions is perceived.

To the physician's apprehension there is in these violent physical phenomena no question of mental conviction or conversion, no evidence of any intellectual process whatever; but solely and simply an involuntary and irrational nervous convulsion, propagated by contagion, truly epidemic in its character, and inviting treatment by medicine like any other physical complaint. The epidemic character of such outbreaks has indeed been conclusively established. The precise aspects of the epidemic may be determined by almost any trivial external incident, and it depends upon something of this

XUM

kind whether the victims shall all mew like cats, as did a whole convent full of nuns in Italy, or imagine themselves monkeys, and try to climb the pillars of the churches, as happened to congregations in Ireland, or shout "Glory!" and roll on the ground, as do the negro ecstatics at Southern revivals.

The Convulsionaries of St. Medard belonged in the same category. They were seized with a furious desire to be beaten, and so transported were they by their hallucinations that they actually endured the most violent blows, not only without sustaining permanent injury, but without showing the least external lesion. In the Irish epidemic, half a century ago, the people of whole parishes were affected, and it was observed that when those who passed from an infected village to one which had previously escaped, the epidemic was spread by contagion, just as a zymotic disease might have been.

In revivals this element of contagion is very powerful, and this is one of the most marked characteristics of hysteria. Merely looking at a person in a convulsion will often throw sensitive persons into a precisely similar state. The phenomena, however, have nothing to do with the will or the understanding. They are physical, not mental, and it is for this reason that they do not produce any permanent effects. The common experience of lay observers respecting the after effects of spasmodic revival meetings is simply a confirmation of the scientific conclusions. The evangelists who operate by means of trances and exciting the emotions of their hearers powerfully often produce very striking effects, but cannot expect any lasting changes in their subjects.

There is mischief in the delusion which confounds hysteria with religion, for the consequences of this mistake are of a kind to disgust sober and rational people, while they afford opportunity for ridicule to unbelievers, and disturb and expose to bad influences the weak men and women who accept them for what they are not. A little sound education in physiology and the elements of medical science would dissipate the hallucination that the evidences of diseased condition are analogous with the proofs of religious conviction.—*New York Tribune.*

THE PHILOSOPHY OF CLOTHING.

By W. Mattieu Williams.

XIV.—THE SEBACEOUS FOLLICLES—EIDER-DOWN.

THERE is one more function of clothing which I suspect is better performed by flannel than by any other clothing material, though I can only supply speculative reasons for this conclusion; direct experiment is wanting.

Besides the glandular apparatus for secreting the sweat, the skin and subjacent tissue contain other glands or follicles, in which hairs and feathers are elaborated from material supplied by the blood. To the sides of these glandular hair-producing sheaths are attached by a little tube or "duct" the *sebaceous follicles* which secrete an oily liquid that is poured into the subcutaneous hair-sheath by means of the ducts. This apparatus lubricates the hair and the quill portion of the feather by supplying a natural soapy pomade, which is rather abundant in some animals, notably the sheep whose wool is very greasy, or I may say soapy, as the "yolk" or "suint" with which it is so largely supplied is partially saponified by potash. The oldest of living chemists, the centenarian Chevreul, published in 1828, an analysis of raw merino wool, in which he found:—

Pure wool	31·23	per cent.
Soluble suint	32·74	„
Insoluble suint	8·56	„
Earthy matter	27·46	„

This is a maximum quantity. Some other wools contain but 10 or 12 per cent. In all cases the quantity is considerable. At present there are works at Rheims, Elbœuf, Fourmier, and Vervier that extract annually about 1,000 tons of carbonate of potash from raw wool, besides the fats. Our manufacturers shamefully waste this product, especially now that by means of bisulphide of carbon it may be so cheaply and profitably removed.

The lubricating of the hair is the function usually ascribed to the sebaceous follicles. Assuming this to be correct, we come upon a curious anomaly in the structure of the human body. We there find sebaceous follicles more fully developed at the roots of certain very minute downy hairs than at those of the stouter and longer hairs. I shall be quite in the fashion of the day if I plunge at once into evolutionary speculation concerning these, by describing them as "survivals" of the once luxurious fur of our remote ancestors; and ascribing the special luxuriance of sebaceous follicles on our noses, above, behind, and by the sides of the nostrils, to the former development of cat-like whiskers thereabouts.

Be this as it may, our noses become greasy in hot weather; other parts of the body also, and the greasy secretion, not being carried forward by the hair, rests upon the skin, attaches to itself dust particles, &c., forming a varnish that is unpleasant to contemplate, and presumably mischievous, if not removed. Besides this, an interesting and disagreeable microscopic object is liable to be hatched and nourished amid the neglected secretions of these sebaceous follicles. This is a large-bodied creature, with eight short legs projecting from the fore part, and bearing the name of *acarus folliculorum*, alias *demodex folliculorum*, alias *entozoon folliculorum*.

That the removal of this greasy secretion is better performed by the contact of woollen fibres than by those of linen or cotton is, I think, presumably proved by the facts above described concerning suint, and the experience of manufacturers of woollen fabrics; that of the fuller especially.

My admiration of Rumford and his work must not stand in the way of impartial criticism. Applying this to his experiments on the relative heat-resisting properties of various clothing materials (see No. 6), a weak point becomes evident. He packed the sixteen grains of the different clothing materials uniformly into the same space around the bulb of his passage thermometer. This was desirable at first, when his object was to determine the relative conducting power of the materials themselves, but after he had by these experiments discovered that it was not the resistance of the fibres themselves to the passage of heat, but that of the air which they imprisoned, a further question was presented, which still remains unanswered, viz., How much of this non-conducting air can a given quantity of each of these fibres respectively grasp and hold entangled with a sufficient grip to check the convection currents whereby alone the gaseous matter carries heat?

Besides this, the experiments, in order to become strictly representative and practical, should be so conducted as to leave the fibres or the fabric externally exposed to the air rather than enclosed in the glass globe surrounding the bulb of the passage thermometer.

When I can find time and opportunity I hope to carry

forward some experiments commenced many years ago with thermometers having long cylindrical bulbs of equal dimensions representing the body of a clothes-wearer. These bulbs are clothed with properly-fitted jackets of the different materials; all raised to a given temperature in a hot chamber, then set to cool down in a cold chamber, and their rates of cooling observed and recorded.

With Rumford's arrangement, eider-down took second place in total time of cooling. (Hare's fur, 1,315 secs.; eider down, 1,305; beaver's fur, 1,296; raw silk, 1,284; sheep's wool, 1,118; cotton wool, 1,046; fine lint, 1,032.) The spun and woven fabrics, as will be remembered, yielded larger advantage to woollen material, and all were much inferior to the raw material.

Among the raw materials above enumerated, only eider down is practically used for clothing in its raw state. It thus takes *practically* the first place, under Rumford's mode of testing it. But this method does not do justice to eider down, as it destroys its specially efficient attribute. To make sixteen grains of eider down occupy the same space as the sixteen grains of other material it must have been considerably rammed—squeezed, into a much smaller bulk than it spontaneously occupies. Had it been allowed to occupy its full bulk, it would have imprisoned a much larger quantity of air, and consequently have achieved a much greater resistance to the passage of heat.

I have no hesitation in affirming that, weight for weight, eider down is the most effective heat retainer of all the clothing materials at present known. Until lately it has been but indifferently appreciated and little used in this country, though well understood and largely used long ago, in North Germany, and North Europe generally.

The eider duck is an Arctic sea bird that sometimes wanders as far south as the Hebrides, the Orkneys, and Newfoundland. It is about the size of the smaller varieties of our common domestic duck, with a more pointed goose-like bill, and flatter head. Its colour is yellowish brown, with black stripes. Like other aquatic birds, it is clad with an underdown composed of delicate fibres as fine as hairs, but much stiffer, and more elastic. This beautiful fibrous structure holds imprisoned an unbroken envelope of air, which not only keeps the bird perfectly dry, but sensibly increases its buoyancy.

Perhaps I should add that this attribution of buoyancy to the aërial envelope of ducks is a heresy of my own, like my denial of the oiling of duck's feathers to keep them dry; but if "G. A." or any other reader is sceptical, let him test the specific gravity of a plucked duck, or a dead duck in wetted feathers, by placing it on the water. The plucked duck will sink; the wetted specimen *may* float, but its height above the surface of the water will contrast curiously with that of the living swimmer. If the reader has still any residual affection for the traditional nonsense concerning feather-oiling, let him pick up a living duck, thrust his fingers into its breast down—that which rests on the water without wetting—and then observe whether any greasiness is left on the fingers. Afterwards do the like with the wool on a sheep. In the latter he will find the greasy condition that should pertain to the duck's clothing if the feathers and down were oiled.

I have at the present moment a loving and faithful duck that feeds from my hand, and follows me like a dog. This docility has enabled me to detect the probable origin of the feather-oiling fables. At times the animal bites the region near the tail very savagely, and proceeds with further energetic nibbling over other parts of the back. I have examined the bill while this is proceeding, but find no trace of oily deposit on it. It is usually wetted very palpably with water. Further observation supplies a very simple and unromantic solution of the proceeding. Ducks, like all other poultry, are infested with fleas; the duck's fleas prefer the non-immersed parts of the body, and hence congregate on the back. Instead of a squeezing out of oil a driving out of fleas follows the pinching which Paley describes.

An Arctic marine bird which, like the eider duck, feeds on marine mollusca, and is consequently exposed to rough surf washing, requires an abundant supply of surrounding air cushion, especially on the breast. This also serves as warm clothing during the bitter winter, but must be rather burdensome in the hot Arctic summer time. At this period it disposes of such oppresive clothing by tearing it off and using it for nest making. So valuable is this down that in Iceland the eider duck is rigidly protected, anybody who kills one is liable to a heavy penalty (30 dols. in nesting time). They are similarly preserved in Norway. When at Vardö (lat. 70° 22″) I had to obtain special permission to visit a little verdant island N E of the town where the eider ducks were sitting. An official duck protector was sent with me. We found the ducks curiously tame. One was lifted off her nest, the mat of down and eggs carried some distance, deliberately examined and replaced; the duck returned and resumed her sitting at once.

The bed of down was about fifteen inches square and two inches thick; about 450 cubic inches of dark grey fluff, with very little admixture of foreign matter. The eggs about the size of our domestic duck eggs, green, or greenish-blue, with black spots. The nests are robbed of their down two or three times, and the duck renews it, finally with some assistance from the drake. If the robbing is repeated oftener, the nest is deserted, and the ducks find another home. Hence the necessity for stringent regulations in localities where they supply a notable revenue, as at Vardö, where a little community numbering about 1,200 are dependent on two harvests, one of codfish, the other eider-down, with a small supplementary crop of a luscious three-lobed, scarlet berry, the *moltebeer*, which covered the duck's island with a rich carpet of its trailing vine, and spotted it all over, when I was there, with millions of white flowers. The scene presented by such verdant and floral luxuriance on a bright sunny midnight in July violently corrects the commonly prevailing delusions concerning the climate of "the Arctic regions."

THE NEEDLE AND THREAD PLANT.

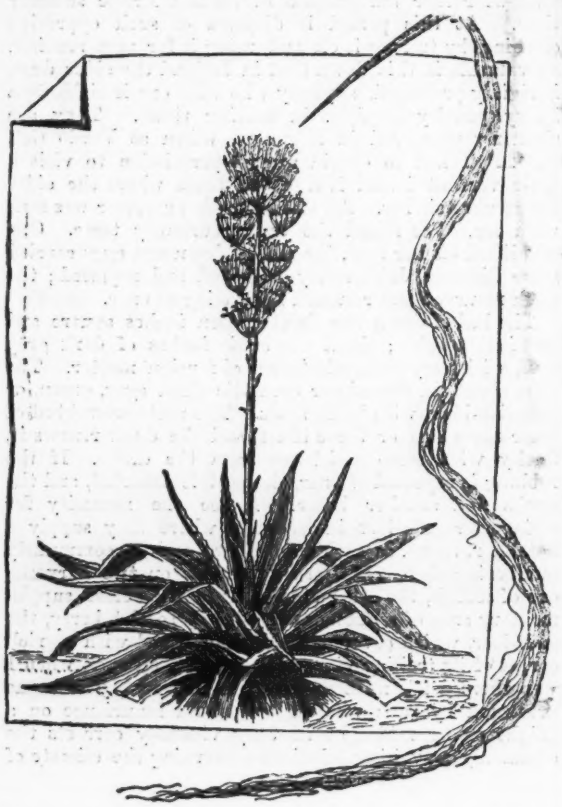
THE *Agave Americana*, or maguey of the Mexicans, is known as the century plant among our collections, the latter name being given to it from the erroneous idea that it bloomed once in a hundred years, and "with such rapidity as to resemble the explosion of a cannon." The period at which the plant really flowers is owing to the climate and the cultivation to which it is subjected. In warm countries twenty-five years is sufficient to bring the flower to perfection. Mr. Hawkins, in his "Transactions of the Horticultural Society," gives an account of the most remarkable instance on record of the flowering of the American aloe. Without manure or protection this plant bloomed in eighteen years, having attained a height of twenty-seven feet, and having on it forty flowering bunches, each with four hundred blossoms,

XUM

making sixteen thousand flowers in all; the scape, with its panicle of rich yellow blossoms, being in appearance like a candelabrum.

The vast plains in the interior of Mexico is the home of the maguey, and the plant with its thorny leaves imparts a peculiar character to the Mexican landscape.

The strange form of the plant and the rarity of its blossoms are not the only circumstances which recommend it to our attention. From the leaves, roots, and sap are obtained a variety of products. "The natives," says Obers in his "Travels in Mexico," "make as many uses of this plant as the South Sea Islanders of the cocoa palm—namely, one hundred." The juice of the sap, which is obtained by making incisions in the trunk, being highly caustic, is used by physicians in cleaning wounds.



Its more extended use is that of producing a bittersweetish juice known as aquamiel (honey water), which furnishes to the natives a drink called pulque, and when taken in moderation is innocuous and wholesome. The foliage of the maguey yields an extract which lathers water like soap.

The agave holds the place of Asiatic hemp and Egyptian papyrus. Ancient hieroglyphics were inscribed on the leaves, macerated in water, and glued together as the bark of paper mulberry. Much attention has been recently paid to the manufacture of paper from the leaves. "The fabrication of this material is destined to be a great industry," says the "Catalogue of Mexican Products," owing to the quality and cheapness of the material.

The fibres of the leaves with the thorns at the end are applied to manifold uses. The edges of the leaves are indented; at each indenture is a spine. These spines are frequently so strong as to serve the Indians for nails. A needle and thread is also furnished the natives by the simple process of pounding the leaf so as to soften the pulp, then scraping the latter away, allowing the fibres with thorns attached to remain. These are dried by hanging in the sun a few days, and the Indian woman has her needle, which is smooth, and not liable to rust; her thread to sew her coarse dress made from "petal flax" (a textile fabric of this plant), prepared in the crudest manner, yet stronger than cotton which has gone through many processes of manufacture.

A rope is made from the fibre of the maguey, which is used in the mines and for the cordage of ships on the western coast. The poorer classes of Mexico thatch the roofs with the leaves, and these, being concave, serve as gutters to conduct the water away from the eaves. The Greek meaning of agave is "noble," and it is well named, as it is one of the most valuable gifts which nature has bestowed on these tropical regions of America. The wealth of a Mexican often consists in his maguey plantation.—*Scientific American.*

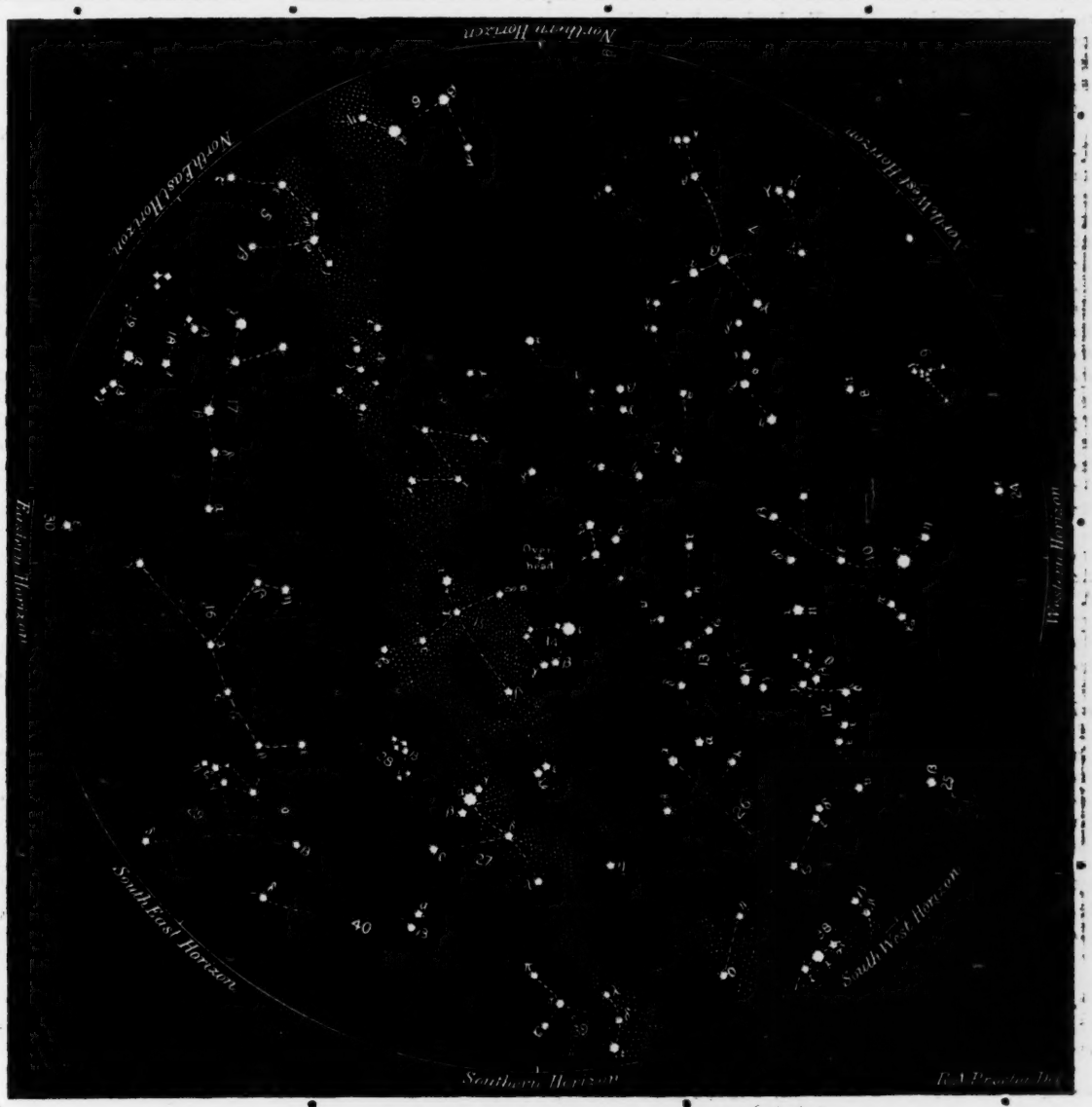
FIRST STAR LESSONS.

By Richard A. Proctor.

THE constellations included in the twenty-four maps of this series are numbered throughout as follows (the names being omitted on the maps, to clear these as far as possible from all that might render the star-grouping less distinct):—

1. *Ursa Minor*, the *Little Bear* (*a*, the *Pole Star*).
2. *Draco*, the *Dragon* (*a*, *Thuban*)
3. *Cepheus*, *King Cepheus*.
4. *Cassiopeia*, the *Lady in the Chair*.
5. *Perseus*, the *Champion* (*β*, *Algol*, famous variable).
6. *Auriga*, the *Charioteer* (*a*, *Capella*)
7. *Ursa Major*, the *Greater Bear* (*a*, *β*, the *Pointers*).
8. *Canes Venatici*, the *Hunting Dogs* (*a*, *Cor Caroli*).
9. *Coma Berenices*, *Queen Berenice's Hair*.
10. *Boötes*, the *Herdsman* (*a*, *Arcturus*).
11. *Corona Borealis*, the *Northern Crown*.
12. *Serpens*, the *Serpent*.
13. *Hercules*, the *Kneeler*.
14. *Lyra*, the *Lyre* (*a*, *Vega*).
15. *Cygnus*, the *Swan* (*a*, *Arided*; *β*, *Albireo*).
16. *Pegasus*, the *Winged Horse*.
17. *Andromeda*, the *Chained Lady*.
18. *Triangula*, the *Triangles*.
19. *Aries*, the *Ram*.
20. *Taurus*, the *Bull* (*a*, *Aldeburan*; *η*, *Alcyone*, chief *Pleiad*).
21. *Gemini*, the *Twins* (*a*, *Castor*; *β*, *Pollux*).
22. *Cancer*, the *Crab* (the cluster is the *Beehive*).
23. *Leo*, the *Lion* (*a*, *Regulus*).
24. *Virgo*, the *Virgin* (*a*, *Spica*).
25. *Libra*, the *Scales*.
26. *Ophiuchus*, the *Serpent Holder*.
27. *Aquila*, the *Eagle* (*a*, *Altair*).
28. *Delphinus*, the *Dolphin*.
29. *Aquarius*, the *Water Carrier*.
30. *Pisces*. the *Fishes*.
31. *Cetus*, the *Sea Monster* (*o*, *Mira*, remarkable variable).
32. *Eridanus*, the *River*.
33. *Orion*, the *Giant Hunter* (*a*, *Betelgeux*; *β*, *Rigel*).
34. *Canis Minor*, the *Lesser Dog* (*a*, *Procyon*).
35. *Hydra*, the *Sea Serpent* (*a*, *Alphard*).
36. *Crater*, the *Cup* (*a*, *Alkes*).
37. *Corvus*, the *Crow*.
38. *Scorpio*, the *Scorpion* (*a*, *Antares*).
39. *Sagittarius*, the *Archer*.
40. *Capricornus*, the *Sea Goat*.
41. *Piscis Australis*, the *Southern Fish* (*a*, *Fomalhaut*).
42. *Lepus*, the *Hare*.
43. *Columba*, the *Dove*.
44. *Canis Major*, the *Greater Dog* (*a*, *Sirius*).
45. *Argo*, the *Ship*.

One of the most important questions to be brought before the International Telegraph Congress, which within the next few days will assemble at Berlin, is Germany's proposal to introduce a uniform and moderate tariff for telegrams between European States. Under the present system many glaring inconsistencies and inequalities exist.



NIGHT SKY FOR AUGUST (First Map of Pair),

Showing the heavens as they appear at the following hours:—

July 21 at 11 o'clock.	August 1 at 10¼ o'clock.	August 13 at 9¼ o'clock.
July 25 at 10¾ o'clock.	August 5 at 10 o'clock.	August 17 at 9¼ o'clock.
July 29 at 10¼ o'clock.	August 9 at 9¾ o'clock.	August 20 at 9 o'clock.

THUNDER-STORMS IN AMERICA.

THE Weather Bureau at Washington began special observations in 1884 for the study of thunder-storms, and the New England Meteorological Society has imitated its example this year. These organisations, as well as individual students of such phenomena, will probably find the recent series of storms much the best which this season has afforded for their purposes. These storms, says an American contemporary, were exceptionally numerous and severe in character, and tend to corroborate some general laws which the Washington Bureau provisionally deduced from last year's investigation. One of those rules is that the great majority of thunder-storms occur to the south-eastward of a centre of low barometer. The odd thing about this is that none happen to the north-eastward; for, ordinarily, in storms devoid of electrical phenomena, rain falls in places almost equally numerous on either side of the generally eastward line along which the low centre advances. When the recent series of storms, with lightning, hail or rain, and destructive gales began, on a recent Friday night, in South-eastern Dakota, the greatest barometric depression was in the North-western corner of that Territory. Of the scores of disturbances that ensued, in Southern Minnesota, Wisconsin, and Michigan, Northern Iowa, Illinois, and Indiana, the province of Ontario, New York, New Jersey, Pennsyl-

vania, and Virginia, New England and the Eastern provinces, not one, so far as heard from, occurred north of the eastward course of the low centre; and, with few exceptions, all were east of a line dropped southward from it.

The precedents apparently established last year were closely followed in two other respects: the tract of country visited by the rain, hail, lightning, gales, and tornadoes widened, fan-like, as it extended eastward; but the hail generally kept within two or three hundred miles of the low centre. In Dakota the belt of afflicted territory was scarcely a hundred miles wide. Near the Atlantic the storms occurred at intervals from Port Hope, on the Canada side of Lake Ontario, to Woodstock, Va. The hailstorm in north-eastern Pennsylvania was probably the one furthest from the low centre, which at the time was a little west of Ottawa.

Whether any of these local storms travelled more rapidly than the low centre to which they were related, as the Signal Office reports might have led one to expect, does not clearly appear from the current news despatches. Another "preliminary deduction" of the Weather Bureau which was not altogether verified at this time is that the activity of storms dies down at evening and revives in the morning. There were some lively demonstrations in this State and Canada on the Sunday night. A point about which there will be some difference of opinion, too, is whether the destructive waterspouts in Southern Mexico on the Saturday and Sunday were connected with the system of storms under consideration.

How far a conflict between two great air currents of widely different temperatures is to be considered a cause of thunder-storms is not yet determined by scientists. Such a struggle, however, seems to have been closely associated with this particular group. A wave of almost abnormally warm weather which extended from the Gulf of Mexico to Dakota on Friday last rolled steadily eastward the next three days, closely pressed by a cold wave of such intensity that in many places in the North-West the temperature in a few hours fell 40° or 50°, and, in at least one instance, 60°. Near the Atlantic seaboard the change was less decided, yet clearly marked.

The number of visitors to the International Inventions Exhibition for the week ending Aug. 1, was 147,661; total since the opening, 1,866,080.

The following statistics refer to numbers of locks and keys made during the last seven years by Messrs. Hobbs, Hart, & Co.—viz., 1,734,000 locks, 3,876,000 keys, 8,483,000 screws and stumps for various locks, and 6,700,090 rivetting stumps for inside work. Also 7,300 safes, 2,308 strong-room doors and frames, and 397 ventilating gates. The wages paid during the period amounted to £195,000.

Are Stays Necessary?—Many women assert that they derive great comfort from stays, that they support the body admirably, and that without them the wearer feels inclined to "drop to pieces." All this may be perfectly true. But what significance must we attach to the statement that certain women cannot possibly do without stays? Do they mean for one moment to assert that the human body is so ill-constructed and so badly adapted for its purpose in life that it has to depend for its integrity upon the productions of a corset-maker? Such an assumption is simply outrageous, the true explanation being that by the persistent use of stays the muscles of the back have become so enfeebled (from prolonged disuse) that they are no longer able to support the spine. Those who declare, therefore, that they cannot do without stays, adopt the argument of the opium-eater, who maintains that he cannot do without his opium. The long-continued use of the drug has so impaired his system that he feels a constant craving for it. And those who cannot exist unless braced up by corsets have so enfeebled a part of their system that they cannot do without the support upon which they have so long depended.—*The Book of Health* for August.

Reviews.

SOME BOOKS ON OUR TABLE.

Real Property Statutes: comprising those passed during the years 1874-1884 *inclusive.* By Harry Greenwood, M.A., LL.M., Barrister-at-Law. 2nd edition. (London: Stevens & Sons. 1884.)—This is one of the numerous books evoked by the changes in the laws that regulate Conveyancing practice. The notes seem practical and full. The system of printing sections of an amending Statute in the middle of the Statute amended, of course exhibits the present state of the law at a glance; but it would seem to us to be liable to confuse the student of a Statute who may overlook the fact that he has parts of two before him at the same time, and the trouble of turning to another page for the amendment is not insuperable. It of course adds to the bulk of the book, as the amending Statute is printed in full elsewhere, *e.g.*, the whole of the Settled Land Act of 1884 appears in this way twice over. That our objections are rather of a theoretical than of a practical nature may perhaps be held to be shown by the fact that Mr. Greenwood's work has already run into its second edition, and we may add that his general arrangement of his subject-matter is decidedly good.

Representation. By Sir John Lubbock, Bart., M.P., F.R.S. (London: Swan Sonnenschein & Co. 1885.)—Every one who wishes to learn how thoroughly Englishmen will be misrepresented under the new Redistribution Act should obtain this little book, which forms the second volume of Mr. Sydney Buxton's "Imperial Parliament Series." As the result of a most careful discussion of the various modes of election adopted in those countries which possess representative institutions, our author decides upon the single transferable vote as that calculated to ensure the fairest expression of popular opinion; and we may avow our own idea that no impartial and unprejudiced reader can fail to be convinced by his arguments. The philologist, alike with the politician, will read with interest the account of the real historical origin of the term "Gerrymander," which is given on pp. 10 and 11.

The History of Herod. By John Vickers. (London: Williams & Norgate. 1885.)—That the monarch of an ultra-tropical locality is not so black as he is painted, is a proverb dating from mediæval times; and in days when Henry VIII. is exhibited to us as a gallant and virtuous Englishman, with possibly merely a little too prominent tendency to uxoriousness to mar his otherwise spotless character, and Bacon is shown to have been above any conceivable temptation, pecuniary or otherwise, it is not surprising to find that that much-abused man Herod should find a defender—and a defender of considerable ability to boot. It is almost superfluous to say here that for our knowledge—or presumed knowledge—of the chief events in the life of Herod the Great, we are indebted to Josephus, whose bigoted sacerdotal prejudices, unfairness, credulity, and historical untrustworthiness Mr. Vickers trenchantly exposes. That Herod was guilty of cruelty he does not deny, but he shows conclusively the difficult part he had to play, and draws a telling parallel between the rebellious Jews, over whom the famous son of Antipater ruled, and the (so-called) Irish "Nationalists" of the present day. Some of the atrocities, however, attributed to Herod are shown by our author to have no foundation whatever. Among them is the Massacre of the Innocents, in connection with which he points

out that the Census of Cyrenius (Luke ii.) did not take place until ten years after Herod's death! and that while Herod was denounced to the Sanhedrin as a murderer for extirpating a band of murderers who had ravaged the Syrian border, and was only saved through the intervention of Sextus Cæsar, no contemporary writer even hints at the atrocious slaughter of all the children in Bethlehem, which must infallibly have been blazed abroad throughout the Empire. To all impressed with the justice of the ancient aphorism, *audi alteram partem*, we would commend the perusal of Mr. Vickers's really remarkable volume.

Studies in Microscopical Science. Edited by Arthur C. Cole, F.R.M.S. (London: Baillière, Tindall, & Co.)—In his four numbers for July Mr. Cole gives us illustrations, with very full accompanying descriptions, of Marchantia, the Tail-feather of a young Starling, Miliary Tubercle and Interstitial Pneumonia, and a Transverse Section of a Puppy's Tail. Thus the histologist, the pathologist, and the general observer with the microscope will find each something to interest him.

Cremation. By. J. G. Davey, M.D. Reprinted from the *Bristol Medico-Chirurgical Journal.* 1885.—The reader must, we think, be either wilfully blind or abnormally stupid who, upon the perusal of Dr. Davey's admirable tract, is not converted to a belief in the ever-growing necessity for cremation as a substitute for the present terribly unhealthy, and, in more respects than one, revolting system of packing limited areas of ground with a seething and festering mass of decaying humanity. This little pamphlet can scarcely be too widely circulated.

The Dietetic Reformer and Vegetarian Messenger. (London: F. Pitman.)—This is the organ of the "Vegetarian Society" (an association of a very few mediocrities with a superfluity of nobodies), who are apparently going to regenerate the world, abolish doctors, and usher in the millennium by the simple process of eschewing wholesome animal food, and confining themselves to a diet of apples, potatoes, beans, turnip-tops, and the like! We are glad to see that the members of this important sect no longer have the audacity to quote Sir Henry Thompson as an advocate of vegetarianism, but have taken to answering (?) him instead.

Blackie's Geographical Readers. I. to VII. By W. G. Baker. (London: Blackie & Son.)—In few branches of instruction has a greater advance been made within the last quarter of a century than in the teaching of geography; nor do we need a better illustration of this than that afforded by Mr. Baker's capital series of "Readers" now lying before us. The child is taught, *in limine*, what a map or plan of its own schoolroom or playground means, and is instructed how to extend this knowledge to maps of larger areas, and shown how the various forms of land and water are conventionally represented, the meaning of the points of the compass, and the like. Then the young student is treated to a picturesque description of England, and is led on to a knowledge of the shape of the earth. After this, England and Wales are treated more in detail, as are the rest of the British dominions in both hemispheres, in No. IV. Nos. V. and VI. deal with the remaining divisions of the globe; while VII. is devoted to the ocean and the planetary system. The series is at once excellent and comprehensive.

Fifth Reading-Book for Standard V. Sixth Reading-Book for Standard VI. (London: Cassell & Co.)—Gradually increasing in difficulty, as in interest, this capital series of books could hardly be improved upon for the purpose for which it is designed. The grandfathers, and even the fathers, of the generation now passing through our public elementary schools would have stood in amazement at these well-edited and capitally-illustrated volumes. We are delighted to see extracts from the work on "Earthworms," of the immortal Darwin, given as readings in the "Sixth Reading-Book."

Cæsar de Bello Gallico. Book I. With two translations. By John Hugh Hawley. (London: Relfe Brothers.) Mr. Hawley has produced a very useful book, and one well calculated to enable the pupil to understand what he is construing—a not too frequent occurrence. On the left-hand page is given the text in full, with a free English translation beneath it; while on the right-hand page the Latin text is split up into the words in the sequence in which they occur in translation, their literal English equivalents standing opposite to them. The boy must be very dull or very obstinate who fails to construe correctly by Mr. Hawley's system.

How to Teach Grammar. By T. J. Livesey. (London: Moffat & Paige.)—Mr. Livesey gives a series of outline lessons for teaching grammar by question and answer. Children will unquestionably be more interested in a subject imparted in the way here set forth than by the old dreary method of learning paragraphs by rote.

A New System of Book-keeping by Single Entry. By Rev. Dr. Brewer. (London: Jarrold & Sons.)—All those to whom the ordinary system of book-keeping by double entry presents difficulty may with advantage study the simple and practical method of single entry explained by Dr. Brewer in the volume before us, and exemplified in a series of working books accompanying it.

Lettice: A Tale in Verse. By Mrs. John Sharp. (Tunbridge Wells: A. K. Baldwin. 1885.)—This posthumous little story is not without a certain amount of grace and interest. In its main incidents it approximates to "Enoch Arden," although its ending is not identical with that of the Laureate's tale. The versification is smooth enough, but here and there the scanning of a line is dubious, and occasionally (though we are bound to say rarely) we come across something like a deliberate defiance of Lindley Murray. "As had belonged to Robert," or "Grew more and more Hugh's company affect," seem to us a little to exceed the limit of poetical licence.

Daisy Dimple: Her Loves and her Lovers. By the Author of "Giles's Trip to London." (London: Jarrold & Sons.)—There is a charm about this simple little Norfolk Idyll, for which it is not, at first sight, easy to account. Almost destitute of incident, and wholly and absolutely free from sensational element as it is, the reader will never stop after opening this account of Dolly's courtship until he (or she) has read to the very end of the book. The author would appear to have had "Mrs. Brown at the Play" in his mind in giving his description of the theatrical booth at Tombland Fair, but every other line in the book is redolent of rural Norfolk. It is a charming and innocent sixpennyworth.

We have also on our table from Messrs. Cassell & Co.: *The Library of English Literature, The Book of Health, European Butterflies and Moths* (with a beautiful engraving of the Death's-head Hawk Moth and its Caterpillar). *The Countries of the World, Cassell's Popular Gardening, Cassell's Household Guide,* and *Our Own Country.* We have further, *Gold and Silver and the Depression of Trade,* by Samuel Smith, M.P., *The Medical Press and Circular, The Tricyclist, Wheeling, Society, Bradstreet's, The Sanitary News, The Sidereal Messenger, Ciel et Terre, Le Franklin, Electricité, The Season, Nature,* and Blackie & Sons' *Educational Catalogue.*

CHATS ON GEOMETRICAL MEASUREMENT.

By Richard A. Proctor.

THE SPHERE.

(Continued from page 75.)

A. Can we determine the volume of a portion of the sphere cut off by a plane as L M N, Fig. 3?

M. Quite easily. Take first the volume, L A N, and let a plane L O N cut the enclosing cylinder in *l n*. Then the volume L A N is equal to the solid sector C L A N, diminished by the cone C L N; and we know by the method of our proof for the whole sphere, that the volume of the solid sector C L A N is equal to $\frac{1}{3}$rd the volume of a rectangular parallelopiped having a base equal to the curved surface of cylinder *t l n* T and height equal to the radius of the sphere; while the cone C L N is also of known volume, when the position of the point O is known. But to get suitable expressions for the volumes of spherical segments we may conveniently proceed as follows:—

Let the angle A C L $= a$; then L O the radius of circle L N $= r \sin a$; C O $= r \cos a$; A O $=$ vers a.

Hence vol. of sector $CLAN = \frac{r}{3} \cdot 2\pi r^2 \text{ vers } a = \frac{2\pi r^3}{3} \text{ vers } a$

$$\text{vol. of cone } CLN = \frac{r \cos a}{3} \cdot \pi r^2 \sin^2 a = \frac{\pi r^3}{3} \cos a \sin^2 a$$

$$\therefore \quad \text{vol. of segment } LAN = \frac{\pi r^3}{3} (2 \text{ vers } a - \cos a \sin^2 a)$$

$$= \frac{\pi r^3}{3} (2 - 3 \cos a + \cos^3 a)$$

$$\text{Similarly, vol. of segment } LEN = \frac{\pi r^3}{3} (2 + 3 \cos a - \cos^3 a)$$

$$\text{Also, vol. of section } BLND = \frac{\pi r^3}{3} (3 \cos a - \cos^3 a) \qquad (1)$$

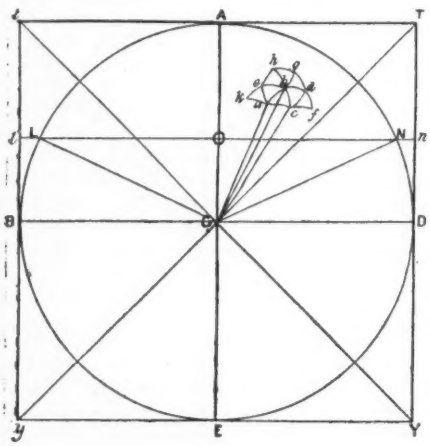


Fig. 3.

This last result is all that need be remembered, and owing to the prevalence of 3's in it, it is very easily held in the memory.

A. What is the volume of a slice of the sphere between two parallel planes, neither of which passes through the centre?

M. We get the same volume whether the planes are parallel or not so that they do not intersect within the sphere. Thus let one be such that the angle corresponding to L C O $= \alpha$, while the other is farther from the centre, and has the corresponding angle $= \beta$. Then, the volume of the space between these two planes, if they do not meet within the sphere, is obviously

$$= \frac{\pi r^3}{3} \{ 3 (\cos \beta - \cos \alpha) - (\cos^3 \beta - \cos^3 \alpha) \}$$

$$= \frac{\pi r^3}{3} \{ 3 - \cos^2 \beta - \cos \beta \cos \alpha - \cos^2 \alpha \} (\cos \beta - \cos \alpha)$$

But we are getting a little outside of geometrical methods.

A. What proportion does a sphere bear to the enclosing cube?

M. The volume of the enclosing cube is $(2r)^3$ or $8r^3$. Therefore

$$\text{vol. of sphere : vol. of enclosing cube} :: \frac{4\pi}{3} : 8 :: \pi : 6$$

$$\text{or roughly,} \qquad :: \frac{22}{7} : 6 :: 11 : 21.$$

A. I think the usual idea is that a sphere occupies a larger proportion than this of the space within an enclosing cube. It is little more than half! So that if you have a box of spherical bodies, say cannon balls, set so that each row falls exactly alongside or above the neighbouring rows, the lines joining the centres forming right angles with each other, the spaces between the spheres amount in all to only 10-21st parts of the whole space!

M. That is so. But the balls can be more closely packed, as when set in triangular or quadrangular pyramids.

A. Which arrangement is the better of these two? I mean for closeness of fitting?

M. They are in that respect precisely the same. I hope, hereafter, to extend our inquiries in that direction.

A. Can we do anything with spheroids and ellipsoids?

M. Our results are very easily extended to them. Thus,—

An oblate spheroid may be regarded as produced by shortening every perpendicular to a certain great circular section of a sphere in a certain proportion, while in the prolate sphere every perpendicular is lengthened in a certain proportion. This circular section is the equatorial section of the resulting spheroid. By taking any plain perpendicular to this section and lengthening or shortening in a given proportion all the ordinates perpendicular to it, our spheroid becomes an ellipsoid. Hence, manifestly, by regarding these perpendicular ordinates as elements of the volume, we get the following results:—

Volume of an oblate spheroid having a for the radius of its principal circular section, and b for its shortest semidiameter

$$= \frac{4}{3}\pi a^2 b. \qquad (1)$$

Volume of a prolate spheroid having b for the radius of its principal circular section, and a for its longest semidiameter

$$= \frac{4}{3}\pi a b^2. \qquad (2)$$

Volume of an ellipsoid having semiaxes a, b, and c

$$= \frac{4\pi}{3} abc. \qquad (3)$$

(To be continued.)

The Great Glacier of Alaska.—According to the *San Francisco Courier*, the great glacier of Alaska is moving at the rate of a quarter of a mile per annum. The front presents a wall of ice 500 ft. in thickness; its breadth varies from three to ten miles, and its length is about 150 miles. Almost every quarter of an hour hundreds of tons of ice in large blocks fall into the sea, which they agitate in the most violent manner. The waves are said to be such that they toss about the largest vessels which approach the glacier as if they were small boats. The ice is extremely pure and dazzling to the eye; it has tints of the lightest blue as well as of the deepest indigo. The top is very rough and broken, forming small hills, and even chains of mountains in miniature. This immense mass of ice, said to be more than an average of a thousand feet thick, advances daily towards the sea.

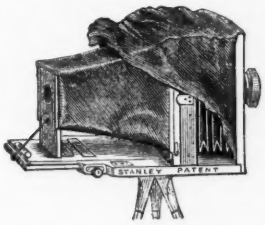
A Medical Electric Lamp.—The electric lamp used for examining General Grant's throat, manufactured by agents of the Edison Light Company, is mounted on a hard rubber holder, about 7 in. long, having a reflector at the lamp end, by which the light can be thrown to any desired angle. The holder is connected by two silk-covered wires to a small storage battery carried in the pocket of the physician. The light is turned on by simply pressing a small button on the rubber holder, and the quantity is governed by another button convenient to the operator. The lamp in inserted in the mouth almost to the palate, with the reflector above the lamp, which throws the light down the throat. The lamp has no unpleasant heat, and gives a light equal to half a sperm candle. The extreme simplicity of the whole appliance makes it very valuable to the physician and dentist.

Colburn's wood and paper brake shoe, a shoe consisting of alternate layers of compressed paper and wood, of about $\frac{1}{4}$ in. each, has, the *Railroad Gazette* says, been recently tested on the New York Elevated Railroad, three cars on the Third Avenue line having been equipped. These cars are stated to have been in daily service for thirteen weeks, making a run of 9,271 miles, against eight weeks and 6,000 miles of the standard metal shoes of the road. This, it is claimed, would equal a run of 200,000 miles on an ordinary road, since the number of stops is about twenty times as many. Quicker stops can be made than with metal shoes, it is said, and naturally with much less wear to the wheel tread. The patentee is L. S. Colburn, of Oberlin, O. There is especial necessity for some other than a metallic shoe on the elevated roads, if it can be had, to avoid the annoyance and danger to eyesight of flying particles of metal.

Our Inventors' Column.

PHOTOGRAPHIC CAMERA.

[Patent No. 4,528. 1885.]—We have here an invention—by Mr. W. F. Stanley, of Railway-approach, London-bridge—in which a separate focussing-cloth is dispensed with. In this camera, by the addition of a light, conical silk bag placed horizontally behind the focussing screen, the ordinary loose focussing-cloth is dispensed with. The same conical bag carries at its apex a magnifier, which answers as a focussing-glass, and the whole apparatus becomes lighter than when the focussing-glass and cloth are separate parts.



At the same time the head of the operator is not stifling under a cloth, or subject to the nuisance of its blowing about or its occasional loss in windy weather. To quite protect the camera from light a second loose silk cover draws over the bellows and open parts. This patented apparatus can be adapted to any camera. An important feature is that the operator is able to look about him at the time of focussing to secure the best view, and avoid any obstruction that may appear from moving objects. The conical bag is made to stand out at the focus of the glass, when required, by pressing it upon two studs.

METALLIC VAPOURS.

[Patent No. 7,731. 1884.]—It is well known both to agriculturists and metallurgists that proximity to smelting-works is not conducive to the production of large crops or to the health of cattle pastured on such land; in fact, the records of our Law Courts show us that manufacturers are continually having to fight actions brought by neighbouring landowners for damage sustained by their property caused by the deposition of acid and metallic vapours from their chimneys.

Many plans have been introduced from time to time in order to prevent the emission of metallic vapours into the atmosphere. Some few of these are chemical, but most mechanical in their action. The plan patented by Mr. Ernest H. Cook, B.Sc., of Bristol, is very simple, and at the same time proposes to recover some at least of the valuable metals, as well as sulphur, which are now allowed to vitiate the surrounding air. The raw material which is used in the process is the waste product from the alkali works. This material, large quantities of which accumulate near chemical works of this description, is at present of practically no value—in fact, is a source of annoyance, and any use for it would be a benefit not only to the alkali-maker himself, but also to the dwellers in the vicinity. When steam or steam and air is blown through this waste, a large quantity of the sulphuretted hydrogen or of the alkaline sulphides, which it contains, are removed and carried along with the steam. If this steam thus charged be brought into contact with sulphurous anhydride, a chemical decomposition ensues, resulting in the deposition of sulphur. Any metallic compounds are likewise decomposed, and the sulphides deposited. The application of these facts to practice is exceedingly simple. In almost all smelting-works the gases from the furnaces are made to pass through a series of long flues and chambers prior to their exit from the stack. In these flues the gases are cooled, and a large portion of the substances deposited. Mr. Cook proposes to pass into these flues, chambers, and passages, at various intervals, the steam charged with the sulphuretted hydrogen obtained as before mentioned. Immediate chemical action occurs, resulting in the precipitation of large quantities of sulphur. The metallic substances present combine with the sulphur of the sulphuretted hydrogen, and are deposited as sulphides. The formation of the solid sulphur by the union of the two gases aids the deposition of the metallic compounds by mechanically enclosing them, and the result is that no metallic vapours reach the stack to be given off into the air.

Thus this process, in addition to affording a protection to the smelter from the, in many cases justifiable, complaints of his neighbours, furnishes him with a means of regaining as a marketable article a substance which is now allowed to escape. When it is mentioned that for every ton of lead made from galena there is produced more than six hundredweight of sulphur dioxide, the importance of recovering the sulphur becomes evident.

The plan is of very general application, as sulphur dioxide is an almost constant product in all metallurgical works.

"Let knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

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THE RUDDY ECLIPSED MOON.

[1847]—May I be permitted to suggest another theory to account for the "ruddy eclipsed moon?" If not a scientific theory it has the merit of being a common-sense one. In the absence of moonlight, when the atmosphere is clear and transparent, and the stars shine out in full effulgence, we become sensible that a large amount of light from that source passes through our atmosphere by the distinctness with which distant objects are seen in considerable detail. The moon, like the earth, is surrounded by the starlit heavens, and should reflect from her surface sufficient light to make her non-sunlit disc more or less visible to us in times of total eclipse, as circumstances are more or less favourable. The pale or ruddy colour must depend on conditions of our atmosphere as to the amount of moisture diffused in the higher regions. If the sun rises in fog it assumes a ruddy colour, which becomes lessened as he rises towards the zenith, even though the fog remains as dense as at his rising. According to this theory, the eclipsed moon should be more ruddy at times when rising or setting in eclipse, and when at or near the meridian in the winter solstice of our atmosphere. Henry J. Madge.

[The "large amount of light" which Mr. Madge appears to suppose reaches us from the stars has no existence, save in his own imagination. Taking *a* Centauri as his standard star of the 1st magnitude, Sir John Herschel determined that a cluster of 27,408 such stars would only give the light of the full moon. There are never more than 1,600 stars visible at one time on the darkest night, and of these, *four*, perhaps, will be of the first magnitude. Further, bearing in mind that it would take 2½ stars of the 2nd magnitude to make one of the 1st; 6 of the 3rd, 16 of the 4th, 40 of the 5th, and 100 of the 6th magnitude to emit the light of a single star of the 1st magnitude, it will easily be seen how wild is the notion that we are indebted to the stars for any sensible addition to the lightness of our nights. Whithersoever we derive it, it is not from them.—Ed.]

THE PAST OF THE MOON.

[1848]—I think there is some value in Mr. Mackie's contention that there might have been men in the moon, but that they had not time to develope as we have done (letter 1812)—Again, they might have been pygmies. Still, when we look back, and see that there must have been human works thousands of years before the Pyramids—such as Uley Bury in Gloucestershire, a quadrangular earthwork which from the moon would be a fine object with a not very high power—and when we consider that the earth is no less habitable, no cooler than in those past æons—nay, much hotter than in some—it seems probable enough that the moon's inhabited days—if there were such—lasted long enough for the lunarians to get as far as *pahs* like Uley Bury.

My chief reason was the absence of river-beds in the moon. I used to spend hours in studying her face with a telescope, and never could persuade myself she ever could have been like the earth in general arrangement. Her hollows are all isolated, like the Caspian—she is like a cinder—whereas on the earth the oceans carry us from one end to another. On Mars, too, this is the case—He has very little water, but it seems to circle all round his continents, like our own "ocean stream."

I think Mr. Proctor says there is evidence of water-work on the

moon. That is very strong against me; but I do not see how there could be water without rivers.

There is nothing to show that planets die, so long as they have their sun. Our latent heat is evidently of no use to us, since our poles are, in spite of it, inaccessible. (We might have immense projections there, for all we know,—were it not that we have seen their shadow on our satellite.)

Mr. Mackie urges that the Great Pyramid has lost 1/22 of its height in forty centuries. That is not much, and it has been by human destruction; which now will probably cease if we keep hold of the country.

I cannot agree with Mr. Mackie (1831) that there is any proof of lunar tides in the past history of the earth; because the heaving of her surface has subjected all parts in turn to the action of the solar tides, which I take it would be considerable—*i.e.*, the difference between a spring and a neap tide.

It is (*pace* Mr. M.) a positive fact that in this country no landscape ever looks blue like a Scotch, Irish, or even English one. How it can be that "the warmer the climate the more water will its atmosphere hold in suspension," is beyond me. I live south of England because the perpetual damp of my native land prevents me from living in the open air half the day, as I do here even in winter. The people here just now are crying out against "the intense heat." In point of fact, the *heat* is not great at all; at this moment 77° in the shade; but the *dryness* is something rare, even for France, and especially for the seaside; and they confound it with heat. Rolls delivered in the morning are, even in a cellar, like ship-biscuit in the afternoon. This I never knew here before: it is therefore the dryest season for the last ten years. Where in G. B. would bread harden like this? If there is *more* water here, it must be a very long way aloft; so long as to become "*un quantité négligeable*," especially as regards the blueness of the landscape, which may be supposed to be nearer.

Mr. M. says "from a chemical standpoint, oxygen and nitrogen *cannot* be 'frozen'"—yet in this very no. of *K.*, at p. 80, it is stated that "Nitrogen is solidified at −214°." Perhaps Mr. M. in his next letter will demonstrate that "solidified" and "frozen" are two different things; as also that the parched Soudan has really more water (somewhere) than "the storm-swept Orcades."

"It was the fine blue of eastern skies which gave birth to the 'waters above the earth' theory." If Mr. M. states this of his own knowledge, he must have been present, one would say as "our correspondent," on that great occasion "when the morning stars sang together, and all the sons of God shouted for joy." I had supposed that rain was a mere obvious origin of the belief.

HALLYARDS.

METEORS.

[1849]—While observing the moon at 9h. 45m. on the 22nd ult. with a 4-inch, by Cooke, power 65, I saw a dark object glide across the face of the moon from west to east, which appeared two inches long and one and a half inch wide. It occupied only five seconds in transit. It was evidently not a bird, there being no movement of wings. It occurred to me that it was possibly a meteor passing beyond the limits of the earth's atmosphere. Perhaps "F.R.A.S." may be able to state whether meteors have been seen in this way. On the following evening, at 10h. 35m., I saw a great fire-ball, or meteor, gliding across the sky in the same direction and near the same spot. The apparition did not occupy more than three seconds, and it was rather of a startling nature. The ball itself was apparently about half the size of the moon; the front part of it was of a white colour, and the tail itself was composed of red flame about two degrees long. It disappeared instantly, without any explosion. As regards its distance from the earth, it really appeared to be about three hundred yards from me. J. WEBB.

[The first apparition spoken of by Mr. Webb was almost certainly that of a distant bird, or of an insect (a cockchafer, or the like) much nearer. Many slowly-flying birds flap their wings less frequently than once in five seconds. There is no recorded instance of a meteorite having been seen dark on the brighter background of the moon or sky.—ED.]

EVOLUTION AND NATURAL SELECTION.

[1850]—"Commentator" reminds us, in his original and effective manner, that "it took five hundred years for Christianity to establish itself." Will it be unfair or ungenerous if I add that Darwinism has only taken five-and-twenty, and has yet to win its credentials from Time, as well as from enthusiastic professors, before it can, without question, be accepted as an explanation of everything? It has, as victor, too, recently come away from conflict with "special creation;" it has to dwell too emphatically upon certain truths to be perfectly reliable. There is more than a suspicion of exaggeration clinging to many of its doctrines; it suggests the swing of a pendulum, or the recoil of a spring, rather than the balance of a true science; and a day may yet come when, over some of it most popular axioms, we shall have to say:—

"Our little systems have their day;
They have their day, and cease to be," &c.

"Commentator," so far as I can gather, does not object to "natural selection" being accepted as a *part* of nature's scheme. He objects to it as a *universal* law. And that is exactly my position. He and I are in perfect sympathy upon that subject, I fancy. Unfortunately, too, many evolutionists are very arbitrary upon this point. They will have nothing but "natural selection"; and they will evolve you a race or an individual from their cut-and-dried formulas, as though the thing possessed no more difficulty than developing a photographic picture.

This is a great mistake: "natural selection" does account for a great deal, and is worthy of profound study; but *alone* it does not account for the existence of any one single thing. It is a guiding influence, not a creative one. It is present wherever there is a conflict, and gives victory to the strongest; but it does not impart life and energy to such. The motive power, the creative impulse, lies far deeper—aye, infinitely deeper—and of that we as yet know nothing. "Natural selection," however, is not everywhere a directing and guiding influence. There are peaceable realms in life (such need not be the lotus-eater's paradise) where nature, far away from the border-lines of strife, can freely make the world the gift of a Plato's mind or a beautiful orchid, a race of musical Bachs or an Ancon sheep.

But, after all, for what is the evolutionist—I mean the recent conventional evolutionist—contending? Is he anxious to prove that nature abhors a leap—that species and races slide imperceptibly into one another? If so, he totally fails. Variation supposes leaps, and Darwin himself recognised the fact. If a bird is born with one feather more than his fellows, it comes into possession of that feather suddenly, and not by imperceptible gradations. So, too, with the six-fingered men, Niata cattle, &c. It thus becomes a question as to the size of the leaps we imagine nature is capable of taking; and it seems to me, in our total ignorance of the prime moving energy underlying phenomena, that it is presumption on the part of Darwinians to assume that those leaps, those steps, can only be of the minutest character. Are we to be told that nature abhors a leap beyond a certain point, as certain philosophers said once concerning a vacuum? If, as Mivart says, there is "an internal force or tendency" in life to produce all we see independently of natural selection, then there is no reason why such a "tendency" should be tied down to infinitesimal gradations. It is a necessity which has grown out of a theory, and that theory is Darwinism.

"Commentator" has often imparted vitality to his views with illustrations drawn from music. It is an art to which, I think, we may more frequently appeal in our speculations with considerable profit. The world is born again in music. It comes to us in new raiment; unfolds its meaning, as it were, in a new set of terms, say as 1, 2, 3, 4, instead of a, b, c, d. The same relations are there, and the same laws. You are strangely conscious of familiar simple ideas, such as softness, hardness, sweetness, richness; and once more you recognise the centripetal and centrifugal forces at work in tonic and dominant.

But can it teach us anything concerning Darwinism? Certainly. In the Tartini tones there is correlation. In the old Greek genera and modern chromatic scale you can observe the small steps upon which the evolutionist now lays such emphasis; nay, in the portamento, if you like, you can point to one thing gliding into another. But there are *breaks* also. There is no bridge to carry you from the common chord to the chord of the 7th; nor in the arithmetical ratios of our diatonic scale is there any link between 6 and 8. The same thing holds good with musical instruments. You may trace the violin back to the crwth by any number of intermediate variations; but from the harpsichord to the piano you must make a leap. I can only throw these things out as suggestions now; but I daresay most of your musical readers will understand their application. GAMMA.

PHILOSOPHY OF CLOTHING.

[1851]—Garters are not necessary where drawers or pantaloons are worn, or with knickerbockers, provided they are ribbed the whole way up. I always wear stockings during the winter, but never garters.

Suffering from the heat, I had a special thin coat made for me, lined with the ordinary silk lining stuff. Although very thin, it is warm, being black and tight-fitting. So I had another made, a thicker coat, and lined with a special flannel. It is also black; though heavier, it is far cooler. I always wear flannel when walking or tricycling for coolness, and find that a winter-coat so lined

is cooler than a summer one lined with the ordinary stuff. I first had my coats and waistcoats flannel-lined over a year ago.

John Alex. Ollard.

OIL-GLANDS IN DUCK.

[1852]—In reply to Mr. Williams, on page 539, he says that Paley describes it as a "specific provision for the winged creation," but does not say for what purpose. There are many naturalist writers of note, both English and American, of a much later date than 1802, who positively state and describe this organ to be an oil-gland—names and quotations from which I could send you (after a little search) if the editor does not think the matter too trivial to occupy space in his paper, when such acknowledged authorities have long ago admitted the fact.

Will Mr. Williams kindly say what he supposes to be the use of the two little heart-shaped glands lying across and just before the root of the tail, traversed by little ducts uniting in a tube, which terminates above the skin in one and sometimes two little nipples, and which is largest and most fully developed in aquatic birds; and if the part be not an oil-gland, why the bird, when dressing its feathers, takes this nipple in its beak, then passes head and throat over the part, and then over all parts of the body-feathers (without the aid of a paint-brush)—for that such is the general habit of birds it would be only idle to dispute? G. A.

HOW TO GET STRONG.

[1853]—Hallyards doubtless knows a great deal, but not everything, or he would not speak of a joiner's *table*. Further, what does he mean by "involuntary motion;" it makes one think of "the jumps." If he means motions such as walking, which when once commenced are kept up *almost* automatically, what reason is there that other bodily motions, such as those described by Mr. Proctor, should not soon become so? They do so as a matter of fact. At one time, when reading and writing a number of hours per day, I worked for exercise with weights suspended by ropes passing over pulleys, a machine commoner in the States than in England I think. I always worked with a metronome, and kept a record so that the pace, weight used, and length of each exercise were noted. The motions became as mechanical as any hand exercise can do, requiring attention merely to do them in "good form," and perhaps, after an increase of difficulty, to keep one going to the end. I can testify to the increase of strength and weight that I gained, and I avoided the risk of strain from rivalry which seems to have been Hallyards' incentive; my rivals were time, pace, and weight, and I did not increase them till I had overcome them. I do not think there is anything "lugubrious" in exercise that sends one's pulse up to 120 and over, nor anything "ridiculous" in exercise that puts on muscle and weight which *stand*, and do not disappear as a gymnast's muscle is apt to do, but my nationality, perhaps, prevents my seeing the joke as Hallyards does. His statement that "a walk without a friend or an object is a saddening affair" perhaps tells a tale. One of the best talkers I know loves walking and talking, and, best of all, walking by, and talking to, himself (in silence). He always, in fact, carries his best friend and companion with him. So much for "the friend." As for "the object," surely to a walker, walking, like "the good" of Plato, is an "end in itself." Is life worth living? This depends on the liver, and perhaps a walk being worth walking depends a good deal on the walker.

Scotus.

THE ORIGIN OF ETHICS.

[1854]—Replying to "Meter," letter 1828, I do not deny the existence or necessity of "beliefs." Where our knowledge ceases, "beliefs" come in. I care nothing whether the tenets I hold can be reconciled with "seeming respectability," provided they are true; but, at the same time, I object strongly to the quiet assumption of certain beliefs to be the source and fountain of all that has been proved to be true by science and experience. I stated, what I believe to be a demonstrable fact—a truth proved by experience, independent of "theological beliefs"—that the ideas of right and wrong arise from the necessities of man; his state of civilisation, education, &c., and that the tests of right and wrong are within our "knowledge," therefore above, and superior to, "beliefs."

Theft, murder, &c., do happen, are perpetrated every day, unfortunately, and I regret "Meter" should produce them in proof of a supreme being, sanctioning, permitting, or unable to prevent them. To me they seem born of dire necessity, fate, or force of circumstances, beyond the control of man in his present state, but entailing to him inevitable consequences, viz., punishment and misery.

In fact, I hold it to be more useful and effectual to teach and to show that, as from tares sown, only tares will spring; so from ill-deeds done, nothing but evil consequences will flow; crime will be followed by punishment of necessity. I would alter Pope's saying: "Whatever is, is good." There is good, evil, and indifferent; let us strive to increase the good, dimish the evil and indifferent.

F. W. H.

[To be operative, this doctrine must be carried out in all its integrity. That is to say, if, for example, a garotter throttles and robs a man from "dire necessity, fate, or force of circumstances," dire necessity, fate, or force of circumstances, should also entail a long term of imprisonment and a severe lashing with the cat-and-nine-tails on that garotter.—Ed.]

THE INCORRIGIBLE CORRECTOR.

[1855]—In letter (1833) "man" is inexcusably and distinctively printed twice—in the first column it was "a highly respectable Moon"—in the second "I doubt whether any nun ever was put to death."

In Mr. Proctor's comments on my remarks on bad English, the irrepressible has again made a hash. The first words of the third paragraph were clearly "Than *who*"—not "than *whom*"—which states the contrary of what we both mean.

I protest against the expression "I should have liked to have seen him" as being absolutely incorrect in the use in which it has obtained, and as laying down an entirely false rule, *i.e.* that a past tense must be followed by a past tense. Mr. P. objects that "I should have liked to see him," really means "I should have liked—*at some past time not indicated*—to see him." Hypercriticism could no further go! Would any sane man imagine that the speaker spoke of anything but the circumstance reported? If this form be incorrect or ambiguous, how could it be expressed in Latin or French, where the equivalents I gave are the only ones possible?

In the third *par*, surely the comments are otiose; for I myself pointed out that "than whom" would of course be correct there was anything to govern the accusative. Just as "I should have liked to have seen him" is no longer *odious nonsense* when we mean what it expresses. As to par. 4—I did not stigmatise the putting of a pronoun first in the same strong language: it really might be justified from the Greek and Latin usage I cited. But it is done a good deal too often, and is parent of much obscurity and still more inelegance. As Mr. P. says "the reader has to wait"—What can be more objectionable than the delivery of a very long sentence whose whole meaning depends upon a verb which is not mentioned till the end? I can read such books as Livy with more comfort than many English writings; but I confess that I am often obliged to glance several lines down, to find the verb which is the coëfficient of the whole, before I form any idea of what the sentence is about. How the people understood speeches so arranged I cannot imagine. Possibly the orator *spoke* the verb first: it may have been a fashion to change the order for the revised copy. I think Cicero in his letters puts the verb first. Was this out of politeness to his correspondent—to make it easier reading? *i.e.*, did he write *letters* as he *spoke?*

A correspondent suggested a campaign against "commence" for "begin," and "penetrate" for "pierce." But the first is not *corrupt* English: it is chiefly an Irish notion, like "convenient" for "near," and "elegant" for "nice." As to "penetrate," it is not synonymous with "pierce." "I did not succeed in piercing into the sanctum" would sound rather *pigeony*.

In my letter about King's College School, "neck-and-neck" was printed "week-and-week." Now the curious thing here is that "neck-and-neck" is a very common phrase, and "week-and-week" is quite unknown.

A year ago we might have said of our conductor,

"He is gone on the mountain—
He is lost to our *knowledge*—
Like a summer dried fountain—
And left us at college!"

Now that "his foot is once more on his native heath, and his name Macgregor," let us hope that in spite of his long submersion his insulation (*i.e.* Britonism) will be found perfect, and himself as good a conductor as ever.

Hallyards.

A NEW WAY OF PLAYING THE GAME OF DRAUGHTS.

[1856]—"The game of draughts is now played out." So the writer in the "Encyclopædia Britannica" declares. This seems a pity, as from its simplicity this game has always struck me as possessing high interest. But if such is the case, I trust I may be allowed to bring before the notice of draught-players a modification of the game I invented some six years ago, and which renders the

game even simpler than before, while, as far as I am a judge, it is made even more exciting. We might call this way of playing the game, "Republican Draughts," because I do away with Kings—there are only men.

The following might be called the "claim" of the method, if this were a patent:—

"Whenever a man reaches the last file of squares, he remains quiescent. For his next move, or for any subsequent move, the owner of the man may remove any one of his adversary's men from the board, and place the man that has reached the last file on the square thus vacated."

This is a much more terrible privilege than mere coronation. The game becomes a very intense affair in consequence. It will be observed that here the men are always moving forwards, except when "removing" one of the adversary's men this way. Hence the same position can never occur twice in one game, and thus no game can be drawn. Hence white has a slight advantage.

I now give an example. Suppose White's men are at 2, 23, 25, 28, 29, 30, 32, and Black's at 3, 4, 8, 11, 12, 13, 14 (Black's men orginally having been on squares from 1 to 12, White's on squares from 21 to 32). Suppose White to play. In the ordinary course of the game the White man at 2 would be a King. But not so here. White removes any one of Black's men from the board that he pleases, and stations his own man from 2 on the vacated square. Thus, in the example, White might remove Black's man at 13 or 14, and his move would be written 2–13 or 2–14. I would not allow White to take off Black's back men—that is, to play 2–3 or 2–4, for that would allow White to exercise the same operation several times till he had cleared off all Black's back men, and this would be too great an advantage. Let the rule be, any man but the back. I need hardly remark that White's man, having thus leapt back, can then resume its march forwards, and is just like any other of White's men. I trust the above explanation will be intelligible, and that all your draught-playing readers will consider the matter. I think if two of them were to play a game over in this manner they would be pleased. I hope some result will follow this article.

There is another matter I would like to suggest, and that is concerning the draught-board. Why should we be bound to the chess-board wiih its paltry thirty-two squares. The Polish draught-board is better; but I wonder that no one has thought of the medium between these—a board with eighty-one squares, the men moving on forty-one of these. In symmetry and elegance it is far beyond either. This will be seen by constructing a diagram of it, and numbering the squares, when it will be found that all the diagonals in one direction are in arithmetical progressions, with five as common difference, and all in the other in progressions of four. This is much better than the common board, where the differences are three, four, or five in either direction. For the ordinary way of playing draughts, this would offer an advantage in that there would be fewer drawn games, because there are no double corners, and, for my new way, it would give more variety of position. After all, any one can make himself a draught-board with some mill-board and white paper. As, however, there can be no drawn games in my way, it would not be of so much consequence to have a board without double corners. However, this is quite a secondary point.

I trust that this way of playing draughts will attract the attention of some leading draught-players; perhaps some of their friends may see this paper, and draw their attention to this article.

ŒDIPUS REX.

"MUSCÆ VOLITANTES."

[1857]—Referring to letter No. 1815, I find in Dr. Smee's book, "Vision in Health and Disease," mention made of "false spots (and chains), which move as the eye moves, and which remain stationary when the eye is fixed steadfastly on an object." It is there suggested that the spots, &c., always exist on the same place of the retina, but this is a mistake. In my own case, although the general form of the chain is preserved, it occasionally shifts its position in the field of view.

My object in writing is to point out to Mr. Thomas that the size of this image floating in the humour of the eye varies in the same way as ocular spectra. If my eye is focussed for parallel rays the appearance is at its largest, while the more divergent the rays become the smaller and sharper is the image.

Does Mr. Thomas's explanation in regard to ocular spectra here apply? INTERESTED.

[The effect spoken of by our correspondent is that too-familiar one to the tired observer with the telescope known as "Muscæ volitantes." They do, of course, shift in the field of vision. They are the shadows of motes in the vitreous humour of the eye thrown on the retina. Obviously, as their angular diameter remains constant they must seem monstrously larger when compared with a very distant object, than they do when contrasted with anything only a foot or two from the eye.—ED.]

TO MAKE IN HIMSELF OF TWAIN.

[1858]—As many of your readers will, I feel sure, consider it impossible that Mr. Clemens or Mark Twain could have fallen into the mistake about "the full moon all the voyage," mentioned in Gossip in KNOWLEDGE of July 17, I send you a copy of some notes I took, intended for the facetiæ columns in the paper we tried to start on board a vessel in which I returned from Australia last year.

Astronomy. A gentleman who has gone into the calculations (thoroughly, he says,) assures me we ought to have a full moon nearly all the way home, if we maintain the rate we are going at.

There was a lunar rainbow visible on the 12th inst. I did not see it myself, but two or three of the passengers have kindly given me the result of their observations. According to one, the bow was complete; according to another, but a very small portion was visible. What struck one observer was the peculiar whiteness of the bow, while another distinctly saw seven colours. There was some doubt as to the position of the moon at the time; some say it had set, others that it was behind a thick bank of clouds, others again that it was shining brightly.

I remember once being flatly contradicted by a so-called well-educated man because I stated that an eclipse of the moon was visible wherever the moon was above the horizon at the time of the eclipse, allowing for clouds of course. J. W. ALEXANDER.

OBSCURE MEMORY.

[1859]—I wrote stupidly about "Arthur's bosom"; corrected in *K.* I at once *remembered* the passage in Henry V., not read since forty years. Why did I not remember it before?

Reading (in O. Feuillet's *Histoire de Sibylle*) of a child who cried for a star, and at last only slept when given a bright object to hold in her hand, (mendaciously warranted a star new-caught) I was seized with a desire to read a packet of letters a century old I believed I had not read. There seemed no conceivable reason for the thought of them coming into my mind. But it was so strong that I hunted them up. What was my surprise to find one sealed with arms whereof the crest was a demi-woman holding up a star in one hand! I know not to whom the coat belonged; to some Austrian brother-officer of a connexion of mine, writing for him (wounded). But I found I *had* read the letters, a year before. Hence it was obscure memory which drove me to them.

HALLYARDS.

"COCK-SURE."

[1860]—The word "cock-sure" appears to be a favourite with KNOWLEDGE at present. Its occurrence in Shakespeare has been pointed out by Mr. Proctor.

Another example of its use by an English classical author may be worth noting.

In Act iv. of Dryden's "Sir Martin Mar-All" (founded upon Molière's "L'Étourdi") the following passage is to be found:—"Nothing vexes me, but that I had made my game cock-sure, and then to be backgammoned." C. F. CLARKE.

LETTERS RECEIVED AND SHORT ANSWERS.

T. C. CLARKE. No, not for celestial purposes. The opinion of which you speak was merely of the instrument as adapted for terrestrial use. Write to W. Watson & Sons, 313, High Holborn, London, W.C., or to J. Lancaster & Son, opticians, Birmingham, saying exactly what you want. Please note, too, the paragraph in capital letters which concludes those heading the correspondence columns.—N. J. O. H. Walker gives "incidental need" as a meaning of "occasion," and Bailey before him, "cause, reason, necessity, or want,"—and so with other Standard Lexicographers. Hence the phrase "I had occasion to go" is no mere vulgar provincialism, but pure grammatical English.—KNOWLEDGE. The nearest approach to a classical symbolic representation of knowledge was Minerva, who was regarded as the goddess of wisdom and learning.—F. W. H. You still sail a little too near the wind. The revolting cant of such productions as that of "Chas. Peace turned Believer," is positively enough to encourage systematic violation of the whole of the Ten Commandments, though.—P. C. B. Will be handed to "Five of Clubs" on his return.—G. G. G. The lines you quote are entirely new to me. Did you find them as a heading to a

chapter in a book? Because pseudo-quotations, the productions of the authors themselves, are not wholly unknown in such a position. —John T. Rae. Your object is a most praiseworthy one; but were I to open these columns to one single appeal for aid, I could not refuse to admit the hundreds which would inevitably reach me in consequence. — Hallyards. Forwarded as you request. You are quite right. I am as jealous of *my* incognito as you are of yours. I would not be intentionally unfair; and most assuredly not to you. Disease or deformity may justify a score of operations which would be—to put it as mildly as possible—useless in the normal condition, and the one you name is very far indeed from being *common*. If my memory serves me, the notice to which you refer was a verbatim reprint, and not an original contribution. That "other correspondent spoke of the acquisition" to which you refer in words which I altered into that form. As for the M.D., I gravely question if any one would notice his ingenious periphrasis. Were I equally clever in the use of it, I could give you my ideas of your contention as to the indication of Divine prescience afforded by—well, by what you refer to. I have no more "animosity" to the curious congeries of works to which you refer than I have to "Gulliver's Travels" or "Phillip Quarll."—A. O. D. Thanks. They break comparatively new ground, and shall both appear.—H. A. B. First part of King Henry IV., act ii., scene 1. I scarcely know what you mean by "the nutritive properties" of water. Boiling it prior to filtering it, renders the destruction of organic germs more certain. It makes the water less palatable, but that is all. Boiled and filtered water subsequently impregnated with carbonic dioxide would be the most wholesome of all as a beverage. Bétal-jews is as near to the pronunciation of the adaptation of the Arabic name of *α* Orionis as can be expressed in print.—Commentator. *Very* eloquent, and full of fine thoughts, but too theological, and certain to provoke an inadmissible discussion on that ground.

Our Chess Column.

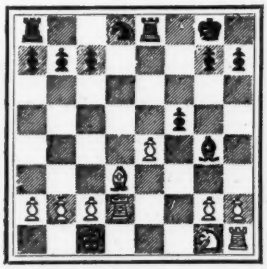
By Mephisto.

ILLUSTRATIVE GAME No. 3.

CENTRE GAMBIT played at Hamburg in the Tournament of the German Chess Association, between J. Minkwitz (White) and J. Gunsberg (Black) :—

White.	Black.
1. P to K4	P to K4
2. P to Q4	P × P
3. Q × P	Kt to QB3
4. Q to K3	Kt to B3
5. Kt to QB3 (*a*)	B to Kt5
6. B to Q2 (*b*)	Castles
7. Castles	R to K sq. (*c*)
8. P to B3 (*d*)	P to Q4
9. Q to Kt5	P × P
10. Kt × P	Kt × Kt
11. Q × Q	Kt × Q (*e*)
12. P × Kt	B × B (ch)
13. R × B	B to Kt5 (*f*)
14. B to Q3	P to B4 (*g*)

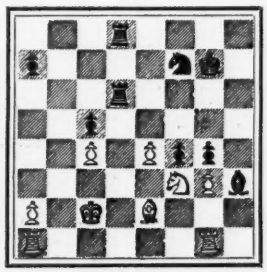
Black.



White.

15. Kt to B3 (*h*)	P to B5 (*i*)
16. Kt to Q4	Kt to B2
17. R to B2 (*j*)	P to Kt4
18. P to KR3 (*k*)	B to Q2
19. P to KR4	P to KR3
20. P × P	P × P
21. B to B4 (*l*)	B to Kt5 (*m*)
22. Kt to B3 (*n*)	B to K3 (*o*)
23. B to Q3	K to Kt2
24. R (B2) to B sq.	P to B4 (*p*)
25. P to QKt3	QR to B sq.
26. P to B4	P to Kt4 (*q*)
27. KR to Kt sq. (*r*)	P × P
28. P × P	KR to Q sq.
29. K to B2	R to B3 (*s*)
30. P to Kt3	B to R6 (*t*)
31. R to QR sq. (*u*)	R (B3) to K3
32. B to K2	P to Kt5!

Black.



White.

33. P × P	K to B sq.
34. P to K5	P × Kt
35. P × K	P × B
36. KR to K sq.	B to B8
37. QR to Kt sq.	Kt × P
38. K to Q3	Kt to B4 (ch)
39. K to K4	Kt to Q5

And Black won.

Notes.

(*a*) We have often explained that the only point in White's favour in this opening is that Black has no convenient square for his KB. But by playing 5. Kt to QB3, White offers a good place for the B on Kt5. Either 5. B to K2, or perhaps better still, 5. B to K2 would make Black's development more difficult; for if Black replied with B to Kt5, then 6. P to QB3 would gain time for White to play 6. Q to Kt3.

(*b*) This move deprives White of the initiative in the attack. Unless White plays Q to Kt3 he can never hope to maintain an advantage. If, instead of this move, 6. Q to Kt3, then we think Black could play B × Kt, followed by R to Kt sq.

(*c*) This is a very important move. White is compelled to protect his P, which gives Black an opportunity of playing P to Q4, always a powerful move, when, as also occurs in the Scotch Gambit, the Q is on K3.

(*d*) There is nothing else. If 8. B to Q3, White's position is worse still, for then P to Q4 would be doubly strong, on account of P to Q5.

(*e*) Played with the intention of still keeping the Rook on the isolated P. But on the whole it might have been simpler to take with the R.

(*f*) This move is played to protect the Black Kt with the QR, and to threaten the KP. Thus Black has entirely deprived White of his advantage of the opening, and created a weakness in isolating his P.

(*g*) At first sight the move looked good, as White cannot play P × P; but in reality it created a weakness in Black's game, depriving him of his slight advantage in position.

(*h*) A fine move. If now P × P, then 16. R to Ksq, B to B4. 17. QR to K2 winning the P back, and having got rid of the isolated P, B × Kt would be no better, for the black Kt is inconveniently placed on Qsq, and R to Q7 would also become embarrassing to Black's game at a future period.

(*i*) A disagreeable alternative to taking the P; for although this still leaves White's isolated P, yet it may become very difficult to defend the P on B5.

(*j*) As will be seen, the KR on Rsq comes into good play presently.

(*k*) It is of importance that this B should be driven back first; the move betrays very good judgment on White's part.

(*l*) Now, the importance of first driving back the Black B can be seen, as White threatens R to R5. If Black plays R × P, then White would win by 22. B × Kt (ch), K × B. 23. R to R7 (ch), K to Ksq. 24. R to R8 (ch), &c. But this move looked stronger than it really was, and is on a par with Black's fourteenth move.

(*m*) Prevents R to R5; also removes the B from his dangerous position.

(*n*) 22. B × Kt (ch), K × B. 23. R to R7 (ch), K to B3. 24. R × P, R × P, and White would have no advantage.

(*o*) Of course, R × P was inadmissible. This move forms the turning-point in the game. If 23. B × B, R × B Black's position is better than White's.

(*p*) An important counter-demonstration; it prevents Kt to Q4, besides threatening P to B5.

(*q*) With the intention of advancing P to B5, if White took the P, thereby breaking up the Queen's wing.

(*r*) Still hoping to maintain the original attack on the K side, for which, however, Black gave White no more chance.

(*s*) This threatens R to Q3 as well as R to R3; it is therefore a far better attempt at doubling the Rooks than R to Q2 or Q3 or R to B2. A matter of judgment, which greatly aids in bringing about winning positions.

(*t*) Black might have played R to R3, to which White would have replied with 31 P × P also R (B3) to Q3, 31 B to K2, &c. But the move in the text is the strongest; as it forces the R away from the B file, he cannot go to B2, as Black would reply R to R3, threatening to win a piece by R × P (ch). Nor can the White R play to Q sq. on account of B to Kt5.

(*u*) 32 B to B sq. was necessary to prevent immediate loss.

Our Whist Column.

By "Five of Clubs."

IT has been suggested to me that occasionally I should give some simple examples of Whist play illustrating the mistakes commonly made in home Whist. The following example may amuse beginners. It will be observed that the hands were so distributed as greatly to favour *A-B*, but by the system of play in which all the winning cards are played out at once, *A-B* lost the

odd trick in the most unaffected manner. With correct play they would have made five by tricks as shown, without any specially strategic feats:—

THE HANDS.

B { S. K, 7, 6. D. 10, 4, 3. } H. Q, 5, 3. C. A, 10, 9, 7.

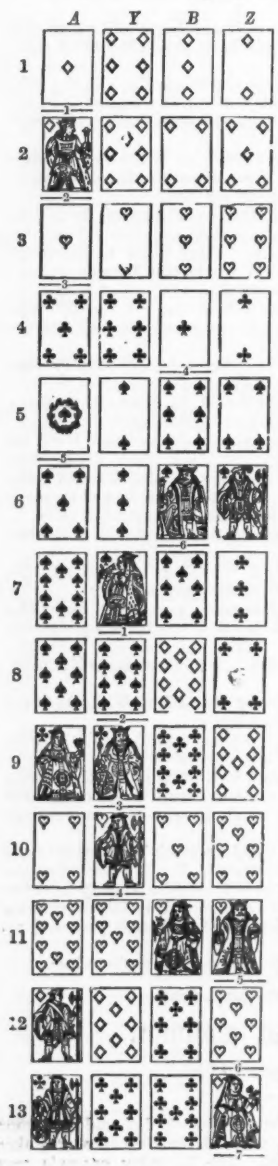
Y { S. Q, 9, 3, 2. D. 8, 7, 6. C. K, 8, 6. H. Kn, 9, 2. }

B / Y Z / Tr. S. 4. / A leads.

Z { Kn, 4. S. Q, 9, 5, 2. D. 4, 3, 2. C. K, 8, 7, 6. H. }

A { S. A, 10, 8, 5. D. A, K, Kn. } H. A, 10, 4. C. Q, Kn, 5.

Score:—A-B, 0; Y-Z, 4.



NOTES ON THE (ABSENCE OF) PLAY.

Card underlined takes the trick and card next below leads next.

A-B having four Aces, two Kings, two Queens, two Knaves, four Tens, and seven trumps to six held by Y-Z, play out all their winning cards before they lead trumps, and thus disarmed lose the odd trick to Y-Z's smaller cards.

1, 2, 3. First disarming.

4. A leads a small Club as the most effective way of disarming in Clubs. Luckily he finds his partner with the Ace, so that yet another card of re-entry is removed.

5. B has no winning cards to play. Being in doubt he leads a trump—an old-fashioned rule which has two meanings, and is here necessarily taken with the wrong one.

8. Y extracts A-B's last trump, and as A-B have no longer a single King card left, Y-Z make all the remaining tricks.

Y-Z win the odd trick and the game.

The game should have been played by A-B as follows:—

1.	D K	D 6	D 3	D 2
2.	S 5	S 2	S K	S 4
3.	S A	S 3	S 7	S Kn
4.	S 8	S 9	S 6	C 2
5.	H A	H Kn	H Q	H K
6.	C Q	C K	C A	C 3
7.	D Kn	D 7	D 10	D 5
8.	D A	D 8	D 4	D 9
9.	C Kn	C 6	C 7	C 4
10.	C 5	C 8	C 9	D Q
11.	H 4	S Q	C 10	H 6
12.	H 10	H 2	H 5	H 7
13.	S 10	H 9	H 3	H 8

1. A shows his strongest suit, leading correctly. But then

2. A leads trumps, having strength in all the plain suits.

3. B returns the highest of two left, so that

4. After this round A knows the Queen to be with Y. Z discards from his worthless Clubs.

5. Y leads a strengthening Heart. B properly covers, for whatever the new school may say to the contrary the rule until recently followed, to cover an honour with an honour second hand, is much safer than the new rule of passing. In the present case had B passed, Z would have finessed the Knave, and retained command of the suit.

6. A leads from his head sequence in Clubs, hoping to be led to in Diamonds and make his Knave.

7, 8. The finesse comes off.

9, 10. A-B make two tricks in Clubs.

11. Force out the trump Queen, and

12, 13. A-B make five by cards and the game.

A DIFFICULT PROBLEM.—In Drayson's "Art of Practical Whist" an illustrative case from actual play is thus introduced, p. 102:—"King is turned on your left, and your partner has shown by previous play that he holds Ace, Knave; three cards, trumps, are in each hand." The problem is to determine how, when one trump only has been played, it can possibly be known from previous play that partner holds Ace, Knave! For my own part, I give it up.

MESSRS. HARPER & BROTHERS, of New York, have, we see, published an American edition of Miss Ada Ballin's admirable translation of Professor Darmesteter's work on "The Mahdi, Past and Present," which we reviewed on p. 528.

LORD JOHN MANNERS stated in the House of Commons on Monday, that the new telegraph tariff will, as we anticipated, come into operation on Oct. 1.

THE Swan Electric Company has commenced an action against Messrs. Woodhouse & Rawson for infringement of their patents. The action is down for hearing, and will probably be tried in November.

THE second annual report of the directors of the Edison and Swan United Electric Light Company, Limited, for the year ending June 30, 1885, states that the accounts show a profit of £12,354. The directors hope to transfer the lamp manufactory from Newcastle to London in the coming autumn. The lamp factory at Newcastle has been working to its utmost capacity. The returns from the Admiralty and other customers as to the duration of life of the lamps supplied by the company are very satisfactory.

Mr. R. A. Proctor's Lecture Tour.

Subjects:

1. LIFE OF WORLDS
2. THE SUN
3. THE MOON
4. THE PLANETS
5. COMETS AND METEORS
6. THE STAR DEPTHS

Each Lecture is profusely illustrated.

Arrangements are now being made for the delivery of Lectures by Mr. Proctor from August onwards. Communications respecting terms and vacant dates should be addressed to the Manager of the Tour, Mr. JOHN STUART, Royal Concert Hall, St. Leonards-on-Sea.

Aug. 11, 12, Worthing; Aug. 13, 14, 18, Brighton; Aug. 20, 21, Eastbourne; Aug. 17, 19, 22, Tunbridge Wells; Aug. 25, 26, Folkestone; Aug. 27, 28, Matlock-Bath; Aug. 29, 31, Burton-on-Trent.

Sept. 1, Burton-on-Trent; Sept. 2, 8, 11, 15, York; Sept. 3, 4, Bridlington; Sept. 7, 9, 10, Scarborough; Sept. 14, 15, 21, 22, Harrogate; Sept. 17, 18, Whitby; Sept. 24, 25, Ilkley; Sept. 28, 29, Derby.

Oct. 31, Marlborough College.

Nov. 4, Burnley; Nov. 9, Stafford; Nov. 12, Middlesbrough; Nov. 17, Darwen.

Dec. 7, 8, 9, Croydon; Dec. 16, 17, 18, 19, Leamington.

Jan. 12, Hull.

Feb. 3, Alexandria; Feb. 10, Walsall; Feb. 18, 25, London Institution.

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